APPARATUS FOR TRANSMISSION OF LIGHT AND POWER BY TWO PHASE ALTERNATING CURRENTS

AS MANUFACTURED BY

STANLEY ELECTRIC MANFG. Co

PITTSFIELD. MASS.

PRESS OF BARTLETT & COMPANY NEW YORK

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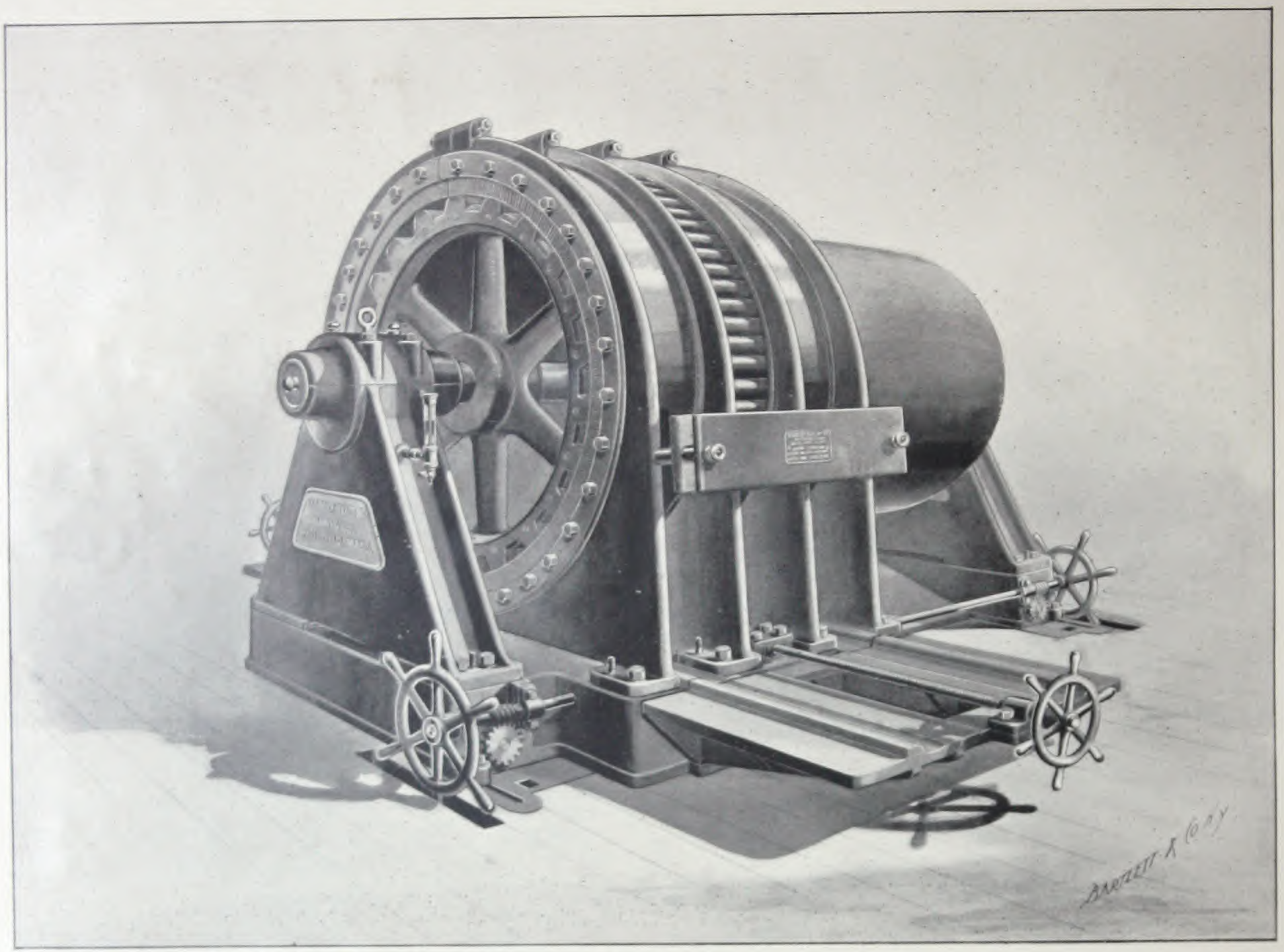


TYPE OF 240 K. W. GENERATOR AND LARGER SIZES.

STANLEY ELECTRIC MANFG. Co

PITTSFIELD, MASS.

W. W. GAMWELL,
PRESIDENT.

W. A. WHITTLESEY,
TREASURER.

HENRY HINE,
GENERAL MANAGER.

Wm STANLEY Jr. - CONSULTING ELECTRICIANS.

JOHN F. KELLY - SUPT. TRANSFORMER DEPT.

JOHN H. KELMAN, -

W. J. DAVIS - SUPT. MOTOR DEPARTMENT.

ROY W. POWER - MECHANICAL DESIGNER.

C. C. CHESNEY,
ELECTRICIAN AND
SUPT. ENGINEERING DEPT.

WESTERN OFFICE, 307 DEARBORN STREET - CHICAGO, ILL.

CONTENTS.

INTRODUCTORY.

THE object of this pamphlet is to introduce to electric lighting companies, electrical engineers and, in fact, to any one interested in the distribution of light and power by electricity.

FIRST.—**A New and Novel Alternating Current Generator.**

SECOND.—**A New and Novel Alternating Current Motor.**

THIRD.—**The First and Only Present Existing Commercial System** for the distribution of Light and Power by Alternating Currents indiscriminately from the same generator and circuit.

For the past three years this Company has been quietly at work perfecting apparatus with the following objects in view:

FIRST.—To produce a system which would permit of economical and satisfactory service of light and power from the same alternating current generator and circuit, and at the same time, a system of such a character that **Existing Lighting Companies** could operate it in connection with their present apparatus without necessitating the discarding of generators, transformers, etc., which represent a large investment.

SECOND.—To produce a system which would make it possible for those just starting in the business to equip a station with one class of apparatus for all purposes, so as to avoid the multiplication of apparatus and circuits necessary in the past where it has been desirable to furnish incandescent lights, arc lights and power.

THIRD.—To make possible the commercial transmission of the energy of water powers over long distances and its distribution for lighting and power purposes by a **simple system** not requiring the many conversions and consequent wastefulness, and the duplication of apparatus made necessary by the synchronous system and other plans heretofore advocated by those having nothing better to offer.

This Company realizes the very great importance of not offering anything for sale which has not been demonstrated, by actual commercial use, to be thoroughly practical and consequently has taken plenty of time to perfect this new apparatus, so that what it now offers is in no sense experimental.

PERSONAL.

Before describing the apparatus justice requires that the inventors of it be given due credit.

Mr. William Stanley, Mr. John F. Kelly and Mr. C. C. Chesney have all contributed largely to inventing and perfecting the machinery and appliances described herein and so closely has their labor been intertwined that the Company has adopted the three initials "S. K. C." as the distinguishing mark of these various devices.

It is but natural that the first complete and practical multi-phase system should be produced by the same men who devised the necessary apparatus and put into actual operation the first Single Phase Alternating Current Transformer System in the United States, which was accomplished by Mr. Stanley and his associates in 1886 at Great Barrington, Mass.

This Great Barrington plant was the beginning and basis of the Westinghouse system, the first successful one for utilizing alternating currents for lighting purposes.

Three years ago, after leaving the Westinghouse Company, Mr. Stanley took part in the organization of the Company bearing his name and it is now a well recognized fact in the history of electrical development that the Transformer manufactured by this Company was the **first good Transformer made** and that its introduction marked, with a sharp line, the beginning of vast improvements in that instrument, improvements from which all central station companies using alternating apparatus have reaped much benefit. Not only has the existence of this Company benefited the central stations because of the great and rapid improvement in transformers which has marked its progress, and the consequent increased economy of operating the alternating current system, but also because of the general result of wholesome outside competition which has forced the two greatest manufacturing companies in the business to serve their customers with better apparatus at fairer prices.

The beginning of improvement in alternating current generators and motors will be just as distinctly marked by the introduction of the apparatus described herein, and therefore it should be known, when "S. K. C." is seen on apparatus made by this Company, that these letters stand for Stanley, Kelly, Chesney.

POWER DISTRIBUTION.

The one great disadvantage of the alternating current system of distribution for lighting purposes has been the fact that power service could not be furnished by it, and it is this fact which has made it possible for the direct current systems to keep some grasp on the field and grow under certain local conditions. Every practical Central Station man knows how advantageous it would be to have in his station but one class of apparatus. The ideal Central Station should have dynamos of but one type, all uniform in size and interchangeable throughout, which deliver current into circuits from which any kind of service, incandescent lighting, arc lighting or power, can be furnished indiscriminately.

Many lighting companies using alternating currents have, in order to supply the demand for power, been forced to use 500 volt direct current generators, thus complicating their equipment and necessitating extra circuits. Even where this has been done, most of these companies have abundant opportunity to rent power at considerable distances from their stations, of which they cannot avail themselves because of the enormous amount of wire which would be required to cover such a wide territory, with direct current circuits, and operate with a degree of efficiency which would be commercial. The very great flexibility and simplicity of distribution of lights by the alternating current transformer system is undisputed by all practical and intelligent station managers and, given a good motor, this system is fully as advantageous for power distribution as for lighting.

From time to time, during the past five years, various motors have been announced as perfected for use on alternating current circuits, but the fact is that none of them have heretofore been demonstrated to be commercially successful, which is the only reason why they are not now in general use. A careful distinction should always be made between commercial, or *money-making* success, and *scientific* success.

A great majority of the lighting companies to-day existing do not run their plants during the day and thus millions of dollars' worth of property is idle a great part of the time which should be earning money. The use of power for manufacturing and other purposes is, however, in the average town, so scattered that it has been impossible to supply the demand profitably with the old systems.

Now this is all changed and a system is perfected by which every lighting company may very largely increase its earning capacity. The furnishing of power should not be considered as secondary in importance to the furnishing of light, as just the reverse is the case in most places, if steps are taken to develop the power business. No one knows what can be done in this line until it is tried, and when once a central station is in shape to furnish power anywhere on its line, and the public knows this, all sorts of demands for it arise which were before not dreamed of. It is a safe statement to make, that in the majority of towns of average size, more money can be made by furnishing power than light. Power from two phase alternating current Motors, such as this Company is ready to furnish, is ideal in its simplicity and convenience of operation. The commutator, that principal source of trouble on direct current motors being removed, there is nothing to cause trouble. Any station may increase its present equipment by adding to it the two phase Generators made by this Company and be in a position to supply power for all purposes. As soon as this is done and a day circuit established there will not only be a demand for power but many people will use light in the day time who did not use it before simply because they could not get it. Bear in mind that power service is more profitable than light service, because, as a rule, it is fairly steady for from eight to ten hours out of the twenty-four, whereas the maximum light service averages only three to four hours.

The two phase Generators this Company offers are fully as good and as simple for lighting purposes as single phase machines. They can be used interchangeably with present single phase machines, and in fact "dove-tail" in with existing systems just as well as new single phase generators.

The two phase Motors this Company furnishes are perfectly adapted for use on currents of the same frequency as the existing lighting circuits, that is, 15,000 or 16,000 alternations, so that to avail of the advantages of this two phase system does not necessitate changing the present lighting transformers in order to secure economical conditions of operation.

By adding our two phase Generators to its present equipment and by combining two existing circuits in a most simple way at the station switch-board, or, at the worst, by putting up one or two more small line wires, a station can equip itself for furnishing power and light indiscriminately in the daytime, and, when the hours of power service are over, the two phase machine can be run on two or more of the ordinary two wire single phase circuits just as well as one or two of the old single phase machines can be run on them. It is not necessary to throw away anything. Present transformers and generators are just as good and useful, and no general and complete revamping or tearing up of the existing system is required.

There is therefore no reason why a station should in future purchase any more of the old fashioned single phase machines where there is any possible chance of renting power.

Where there is no present possibility of renting power, or any probability of future demand for it, single phase generators may be as good, and to meet such conditions we will furnish single phase generators constructed on the same plans as our two phase.

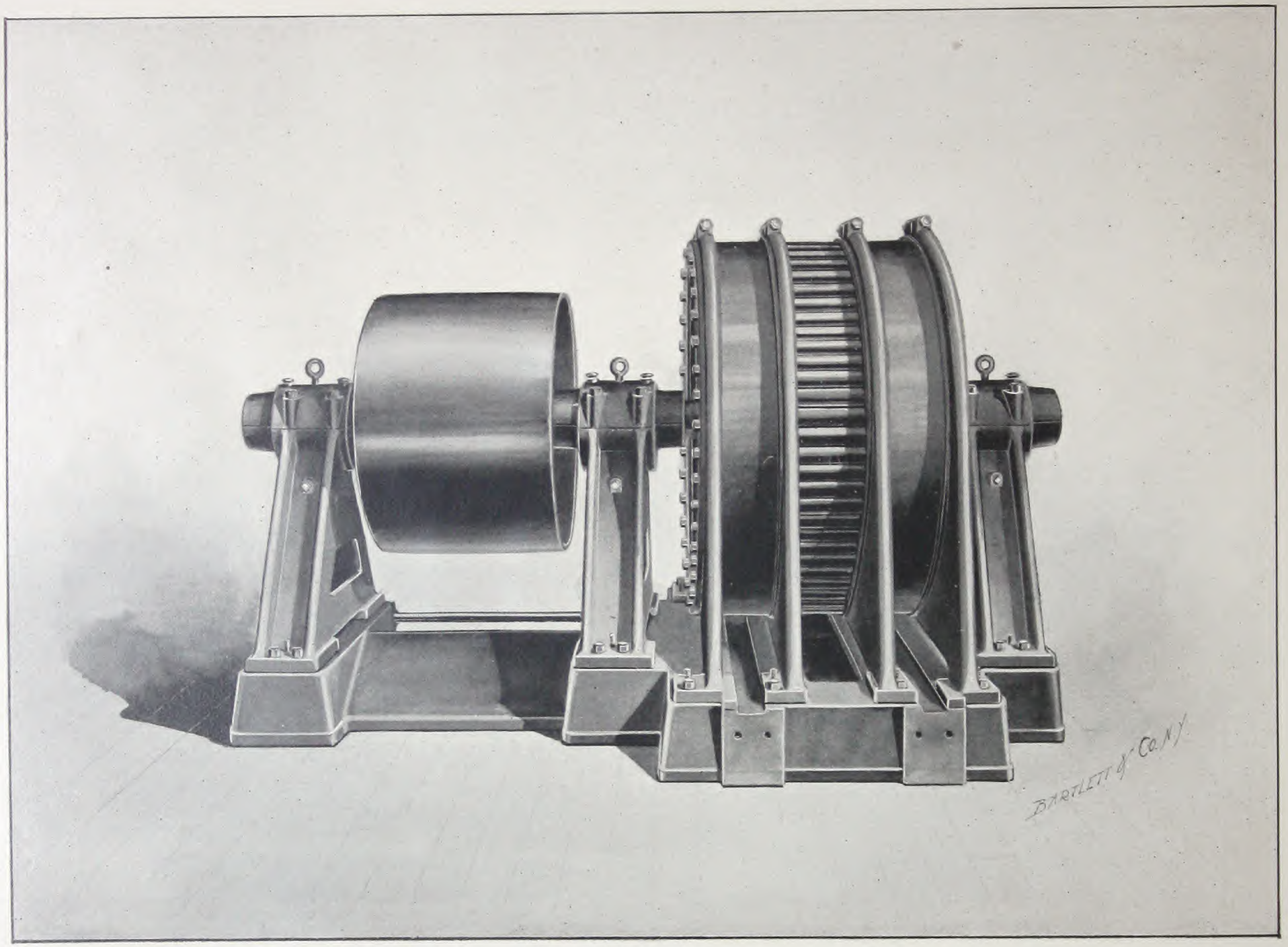
THE TWO PHASE SYSTEM.

The only good reason for the existence of multi-phase systems is the fact that no one has yet produced a single phase motor which commercially answers the requirements of power distribution. Admitting then that multi-phase is necessary, it is evidently best in its simplest form, which is two phase. In some cases where a very large amount of energy is to be conveyed over a very long distance to a centre of distribution and where, consequently, the cost of line wire is an important part of the total cost of the plant, there are some strong arguments in favor of the three phase system, but already there are various methods suggested of changing the number of phases at will, by accessory apparatus, to meet such conditions, and there seems, therefore, to be no doubt but that two phase is the best basis for all extension of alternating current work. For the usual conditions met with in the distribution of light and power through cities and towns the two phase system is much more practical and simple and therefore more economical in operation.

WHAT IS NEEDED

by existing stations is a system that will **fit on to, and work in with,** their present plants and enable them to furnish power from self starting motors taking current about in proportion to their load.

This Company offers the only such system yet produced.



SIDE VIEW OF LARGE GENERATOR.

No other manufacturer even pretends to furnish a general line of motors of all sizes which are efficient and practical on alternating currents of the existing frequencies.

A most important element in such a system is regulation, so that as motors are started and stopped, or their load increased or decreased, lights on the same circuit will remain practically uniform and not be made to flicker.

Owing to the heavy false currents attending the use of the alternating current motors heretofore made, such regulation has been impossible because, on this account, not only have the motors required excessive currents on light loads, thus drawing heavily on the transformer, line and generator, but these false currents also have the effect of demagnetizing the transformer and generator, thus reducing the E. M. F. on the whole system and causing serious fluctuations in the lights.

This question of regulation is more fully treated in the part of this pamphlet describing our Motors, pages 35 to 46. We call special attention to our general guarantee covering this subject of regulation on page 47.

FREQUENCY.

There has been a great deal said in the journals, both foreign and domestic, during the past three years about this question of frequency. The reasons are these :—

First.—An alternating current motor, operating substantially as direct current motors do, has been greatly desired.

Second.—All who have endeavored to make such motors have found the false currents developed in them a most serious disturbing factor.

Third.—These false currents are created in a less degree as the frequency is reduced.

Therefore there have been advocates without number of low frequency, all of them, however, more or less directly interested in the production and sale of alternating current motors.

Undoubtedly, for very long distance transmission there are other reasons for using a lower frequency than the standard heretofore used in this country, but millions of dollars are now invested in apparatus of this frequency and apparatus of a much lower frequency can not be grafted on to these existing plants and operated in connection with them economically. Instead of adopting a low frequency, Messrs. Stanley, Kelly and Chesney have invented methods of eliminating these false currents, even where the high frequency of 133 p. p. s. (16,000 alternations) is used. One of these methods is fully described in the portion of this pamphlet describing our two phase Motors.

Another important consideration in this connection is the fact that the inherent regulation of a well designed alternating current generator is impaired in direct proportion as the frequency is reduced. That is, if the regulation of a machine of a given weight, speed and efficiency is 6% at 16,000 alternations, it will be 12% at 8,000.

THIS COMPANY'S POSITION,

therefore, on this question of frequency is as follows:—

FIRST.—Where existing stations already have a large investment in alternating apparatus, increase this equipment with two phase apparatus of the same frequency.

SECOND.—Where a new station is to be established, adopt a frequency which will give the best all around economy, considering the loss in the line and the first cost and economy of operation of transformers. For very long distance transmission the loss in line due to inductance is an important consideration, and this is reduced by lowering the frequency; but, as lowering the frequency entails either increased cost of, or waste in, transformers, and inferior regulation of the generator, care should be taken not to go to the extreme in this direction.

THE GENERAL RULE THEREFORE IS: *Keep the frequency as high as the local conditions will permit in order to obtain the most economical operation and, at the same time, render satisfactory service to customers*

The standard frequency heretofore used in this country is very favorable to economy in transformer construction and operation. Lower frequency necessarily increases either the cost or the leakage current of transformers.

There has of late been considerable apparatus sold in this country of from 7000 to 8000 alternations (about 65 p. p. s.), the principal object being to obtain lower speed in generators. With this frequency the increased cost of transformers, to obtain fair results, is not so very serious, but with lower than this, say 6000 alternations and less, the questions of first cost and economy of operation of transformers assume very great importance. **Beware, therefore, of these very low frequencies.**

This Company builds its standard Generators of either 16,000 or 8000 alternations, and Motors for either frequency. The type of our Generators enables us to make them of the same speed for either frequency.

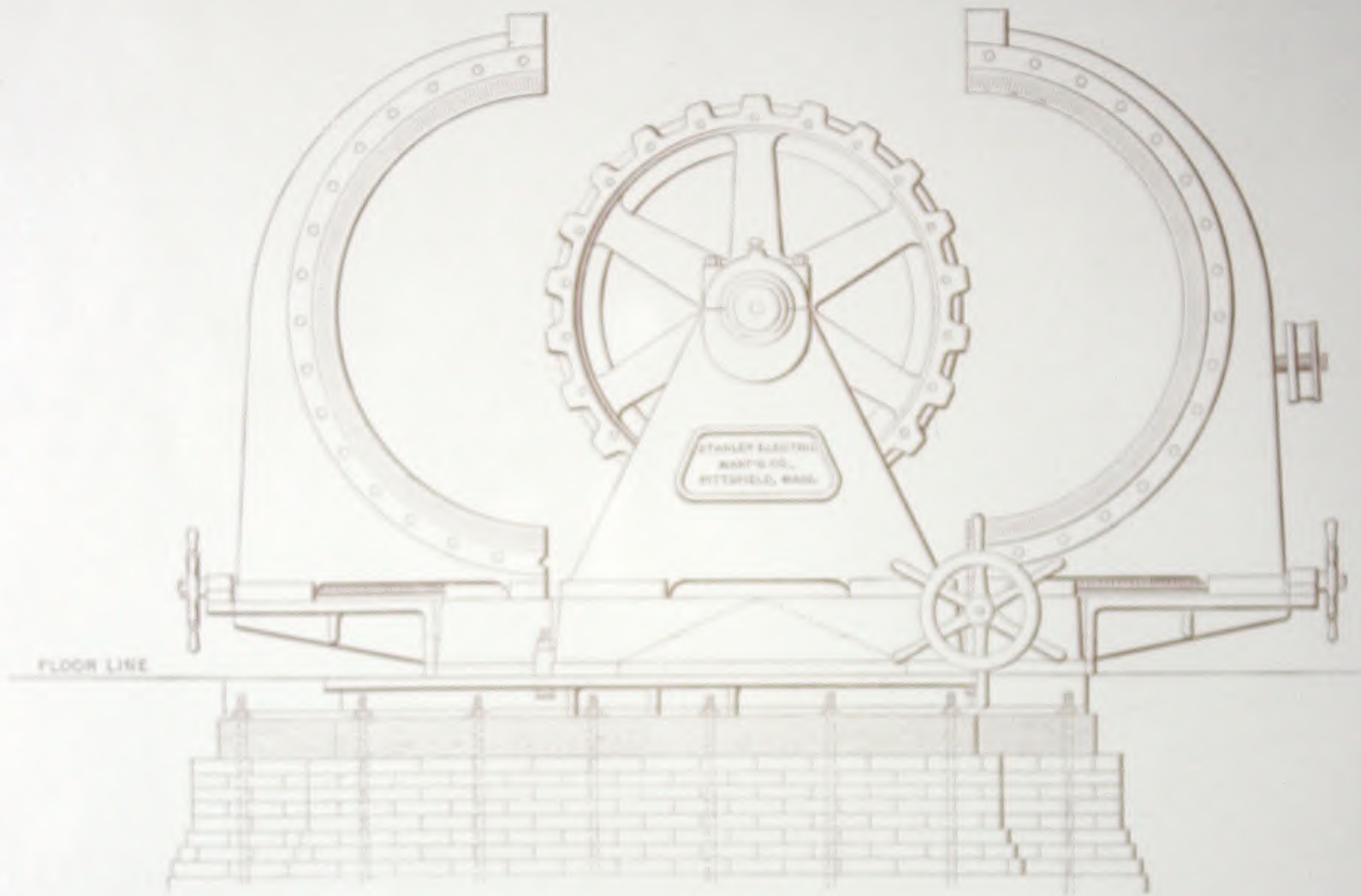
We are also prepared to build to order special generators, of any desired frequency different from these standards, when made necessary or desirable by peculiar local conditions.

A WORD ABOUT PATENTS.

We wish it distinctly understood that the apparatus described in this pamphlet is novel, different from anything heretofore made, and covered by patents which will fully protect us and our customers.

We wish not only to emphasize the fact that we are not infringing patents belonging to others but also that we shall avail ourselves of the patents under which we operate to protect ourselves from piracy by other manufacturers.

The system we offer is our own, invented and perfected by our own electricians. The novelty of our Generator will be apparent at a glance, and in principle our Motors are fundamentally different from the so called Tesla or any other form of alternating current motor before the public.



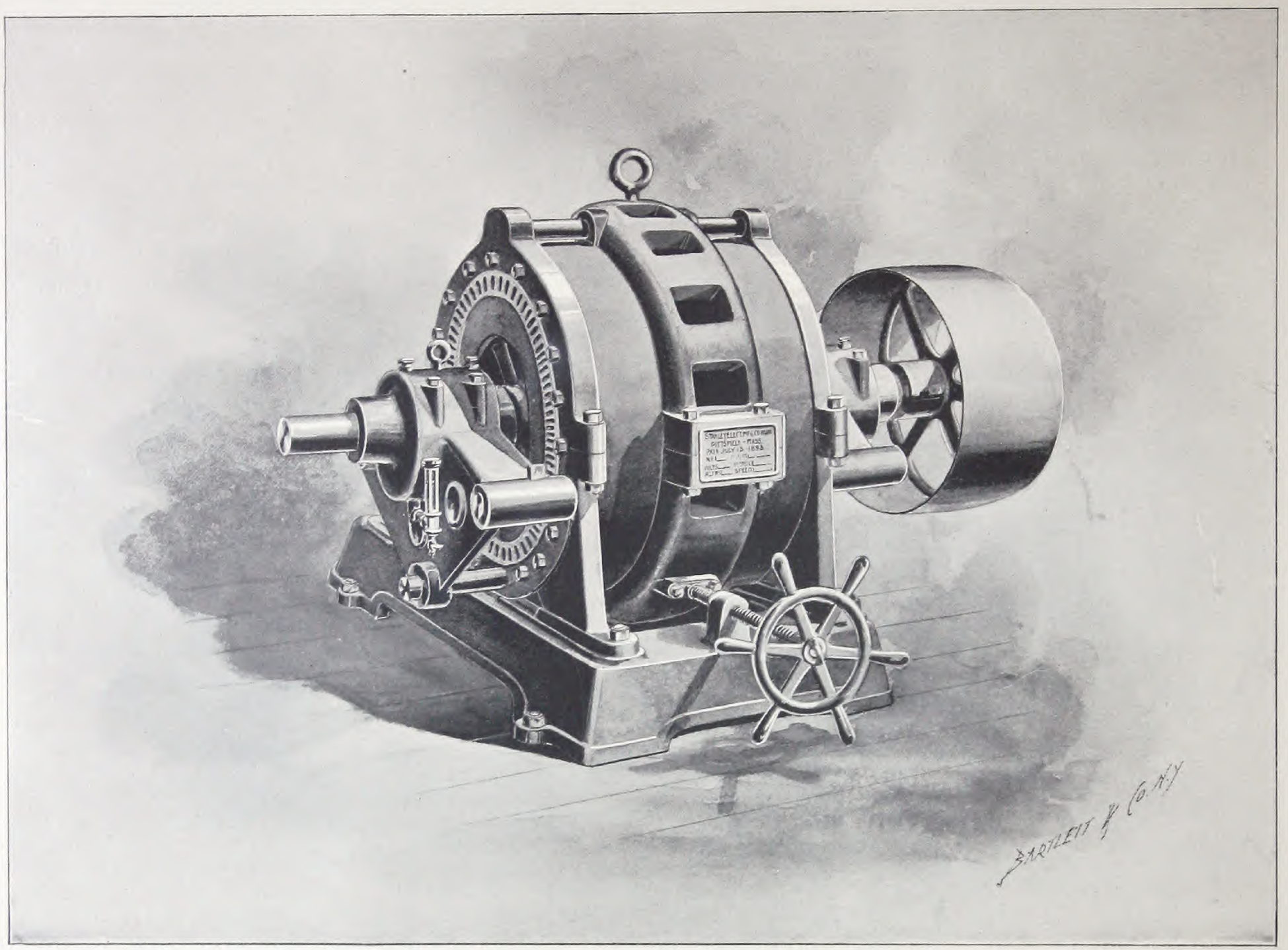
OUTLINE OF LARGE GENERATOR DRAWN APART.

Multi-phase systems, *per se*, are public property and any claim to the contrary is founded either on ignorance or intention to deceive.

There has been in the past plenty of newspaper description of alternating current motors, but nothing practical produced, nothing which could be commercially and commonly used for the general distribution of power in towns and cities.

The best evidence that our Motors are different is the fact that they are commercially useful and that power and light is now being, and has been for a year past, distributed from the same Generator and circuit by our system on a successful commercial basis.

What we claim for our system is based therefore on practical results and not on a desire to boom any particular inventor. It is only natural that the central station companies should be skeptical about alternating motors which have been talked about for six years, but which they cannot purchase when they want them, or find anywhere in operation, and because of this skepticism we have purposely delayed describing our system until actual commercial use has demonstrated that, by doing so, we would not endanger our reputation for reliability.



TYPE OF 60 K. W. AND 120 K. W. GENERATOR.

THE GENERATOR.

The illustrations give a very complete and clear idea of the construction of our Generator. **Simplicity** and **Dignity** are the two most striking features of this machine.

It is simple because it has **no moving wire; no collector; no commutator.**

It is dignified because **it is massive and strong; it runs at low speed.**

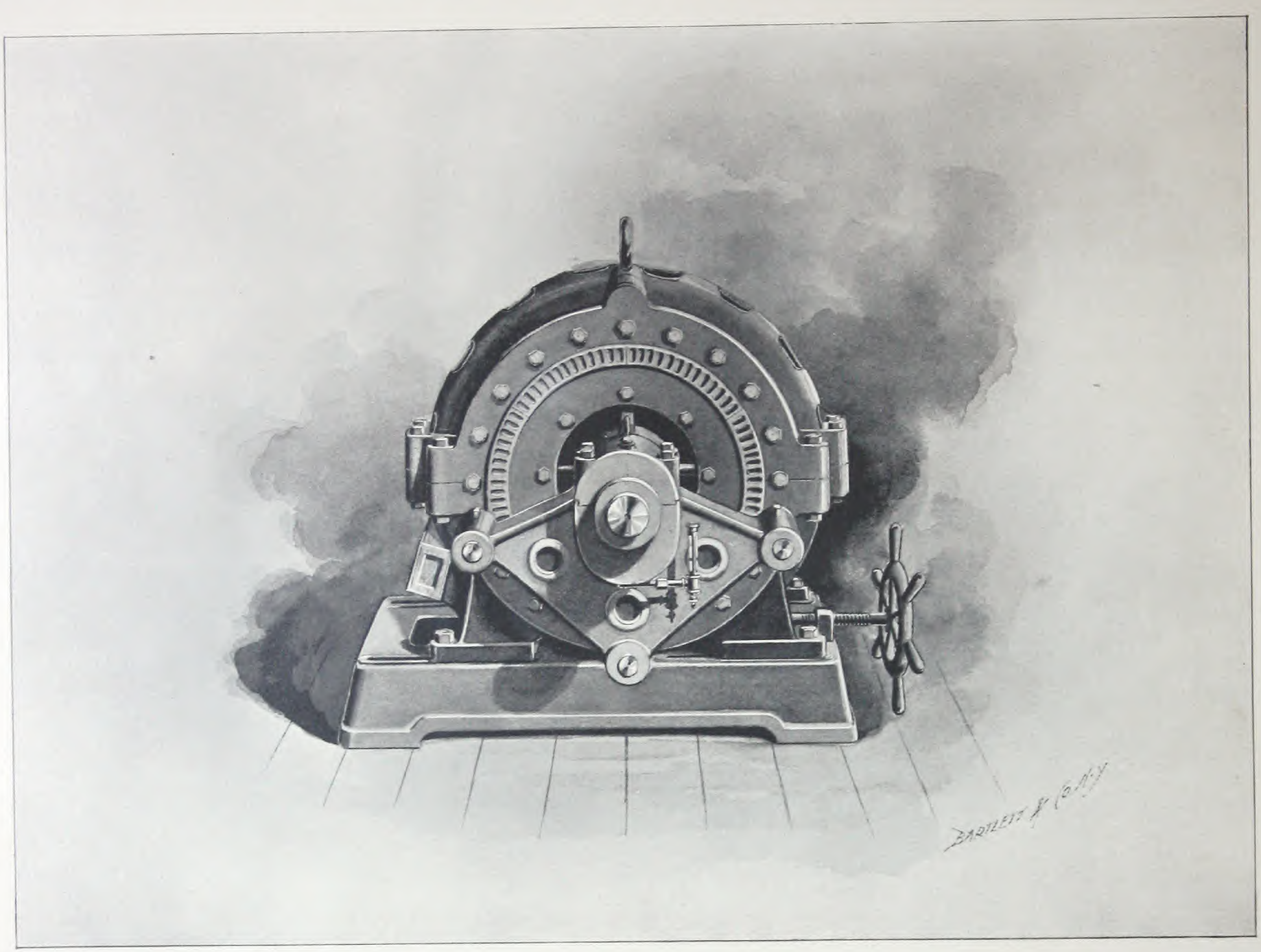
If to gain these points nothing is sacrificed in electrical properties, the superiority of the Generator cannot be questioned.

We not only do not sacrifice anything in this way but, on the contrary, get **better electrical results** than those obtained from any of the old fashioned alternating current dynamos.

The frontispiece and cut on page 14 represent the form of machine in sizes of 240 K. W. and larger.

The cuts on pages 20 and 22 show the type of the smaller machines, 60 K. W. and 120 K. W.

The electrical design is the same in all, the larger sizes, however, requiring different mechanical construction.



TYPE OF 60 K. W. AND 120 K. W. GENERATOR.

The revolving part of this machine is really the Field, but is more properly termed

THE INDUCTOR.

This is made of a steel casting upon the periphery of which polar projections of iron laminæ are securely fastened. There is no wire whatever on this Inductor and consequently there are no band wires to break, no necessity for insulation and no use for a collector.

Instead of being a delicate sensitive thing to be handled carefully, insulated perfectly and feared always, like the revolving parts of other dynamos, it is simply a mass of metal which can be put in place and revolved with a feeling of perfect certainty that nothing can happen to it.

The Inductor is well shown in the cut on page 26.

THE ARMATURE.

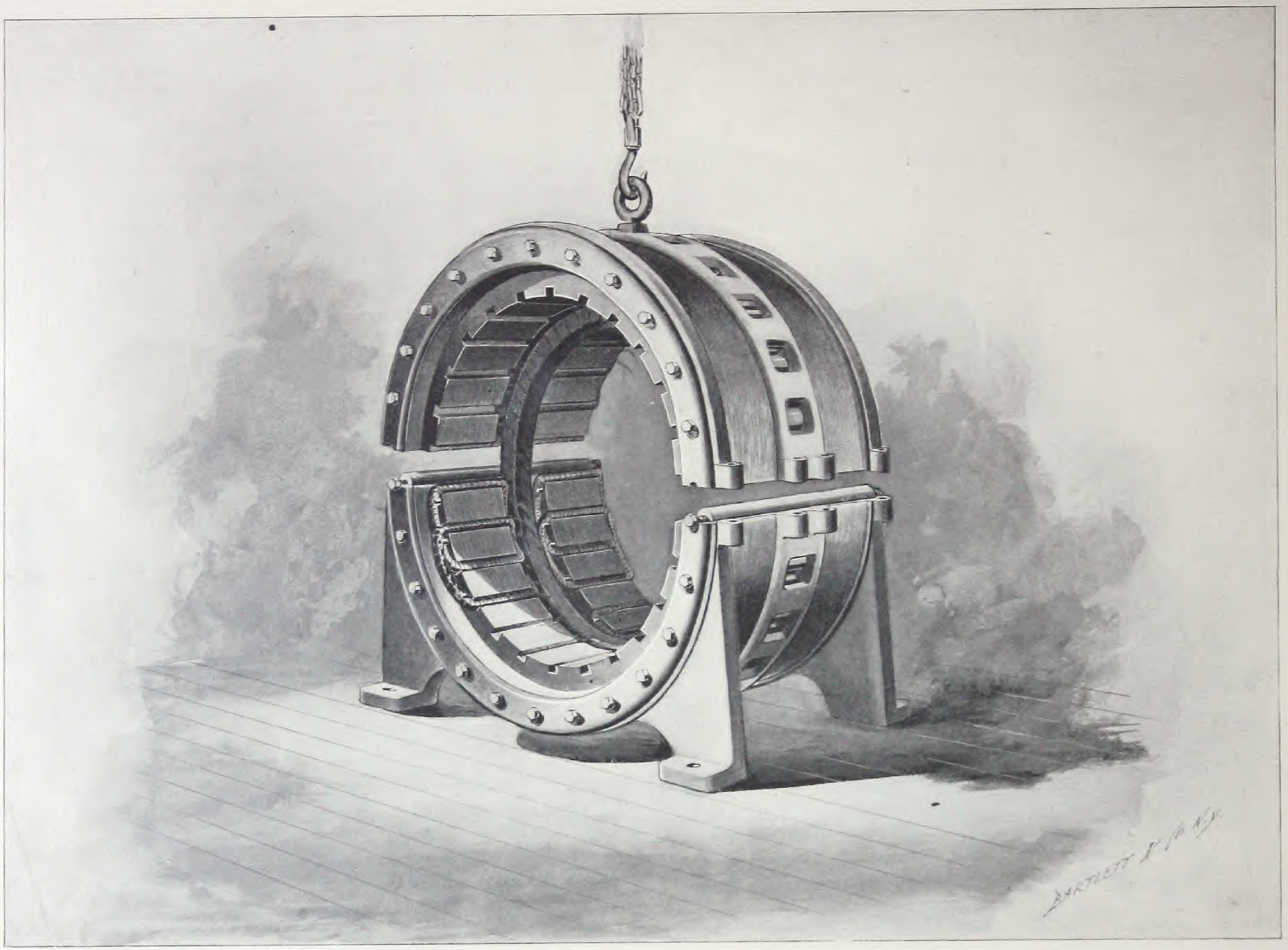
An Armature is of course necessary, but, in the form it assumes in our machine, it **loses its terrors.**

This is well shown in the cut on page 24. It will be seen that the Armature is made up of laminæ of iron and is stationary, constituting, in fact, the body of the machine.

The individual coils are comparatively very small, are wound separately on forms and then secured in grooves provided for them in the laminations. Being so small and stationary it is a comparatively simple matter to insulate them to safely withstand pressures (E. M. F.'s) which it would not be at all safe to generate in the old fashioned machines.

If a coil should be destroyed by lightning, or any other cause, it can be readily replaced by the ordinary men employed about a station, as any one can see at a glance.

A few extra coils are furnished with each machine. If more are needed they cost very little; a single coil for a 120 K. W. machine, for instance, being furnished by us for $3.50.



ARMATURE, SHOWING COILS.

THE REPLACING OF AN ARMATURE COIL is made as simple as possible. In the small machines it is only necessary to take off the top half of the bearings, lift off the top part of the Armature and raise the Inductor, when all the coils are easily accessible.

In the machines of 240 K. W. capacity and larger, the great weight of the parts would make this plan very inconvenient in many stations, and we have therefore designed the extremely convenient and simple plan shown in the frontispiece and in the cut on page 14.

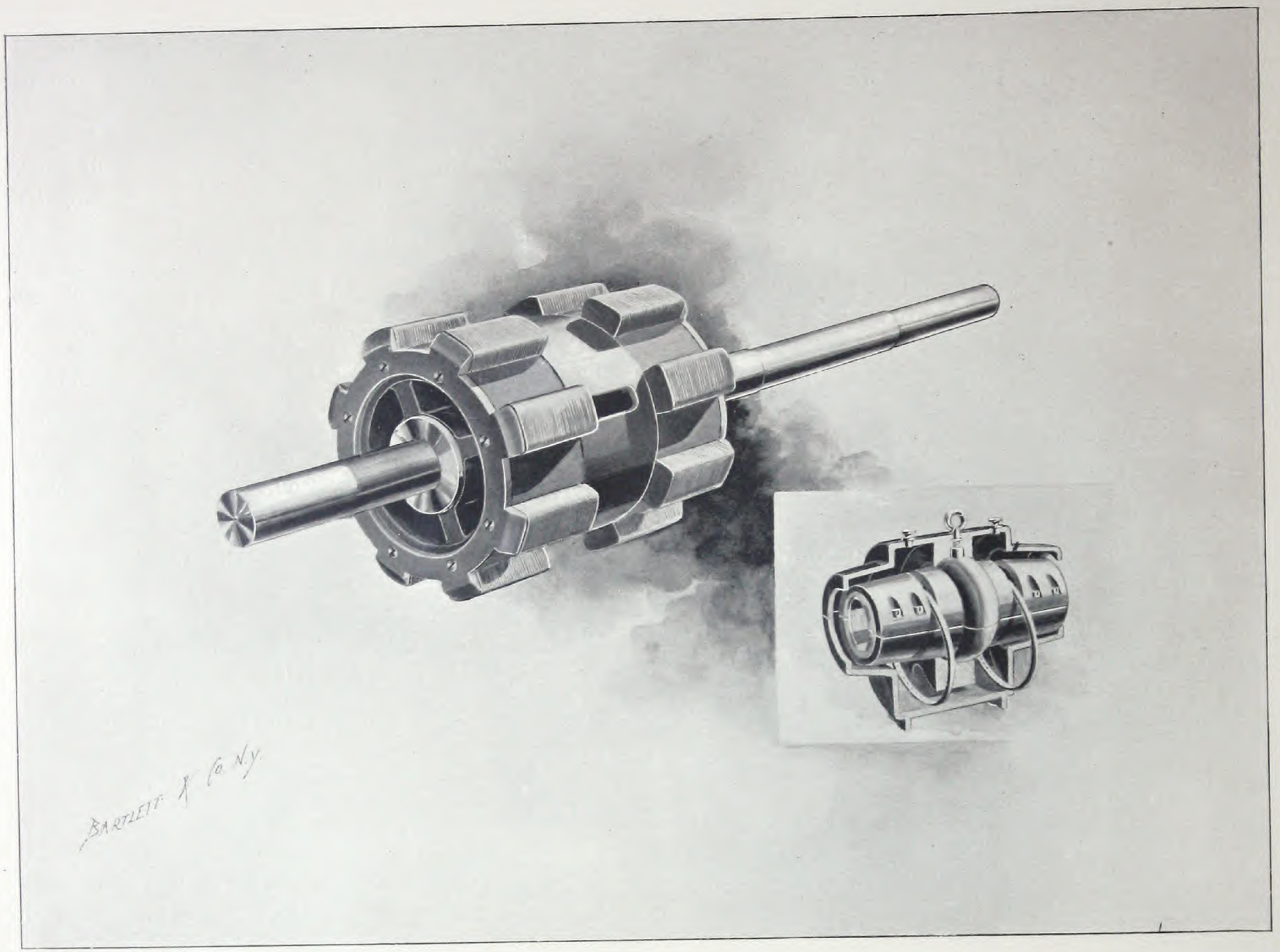
Removable side tables are furnished with the machine, so that by turning the hand screws on each side it can be drawn apart and all the Armature Coils exposed and made easily accessible.

Notice that this does not require disturbing the Inductor at all, which when the machine is opened, simply hangs in its place in the bearings. The side tables need not be kept in place except when needed, as they are removable. The diagram on page 18 shows, in outline, the appearance of the machine when opened. No special tools or appliances are necessary to insert a new coil, such as are required with the toothed armature type of machines on the market, in which the coil has to be forced under the teeth to keep it from being thrown out of place by the centrifugal force due to the rapid revolution of the armature.

The ease of repairs to these so-called toothed armatures is widely advertised, but in practice the replacing of coils in them is quite a task, as all can testify who have tried it. Our Armature Coils being stationary this work is much simplified, and each coil being so small, the expense is also much less.

THE BEARINGS.

On page 26 with the Inductor is also shown the details of the Bearings. These are of the most approved self-oiling type, are very carefully constructed of the best materials and are very generous in dimensions.



BARTLETT & CO. N.Y.

INDUCTOR AND BEARING.

THE TERMINAL BOARD.

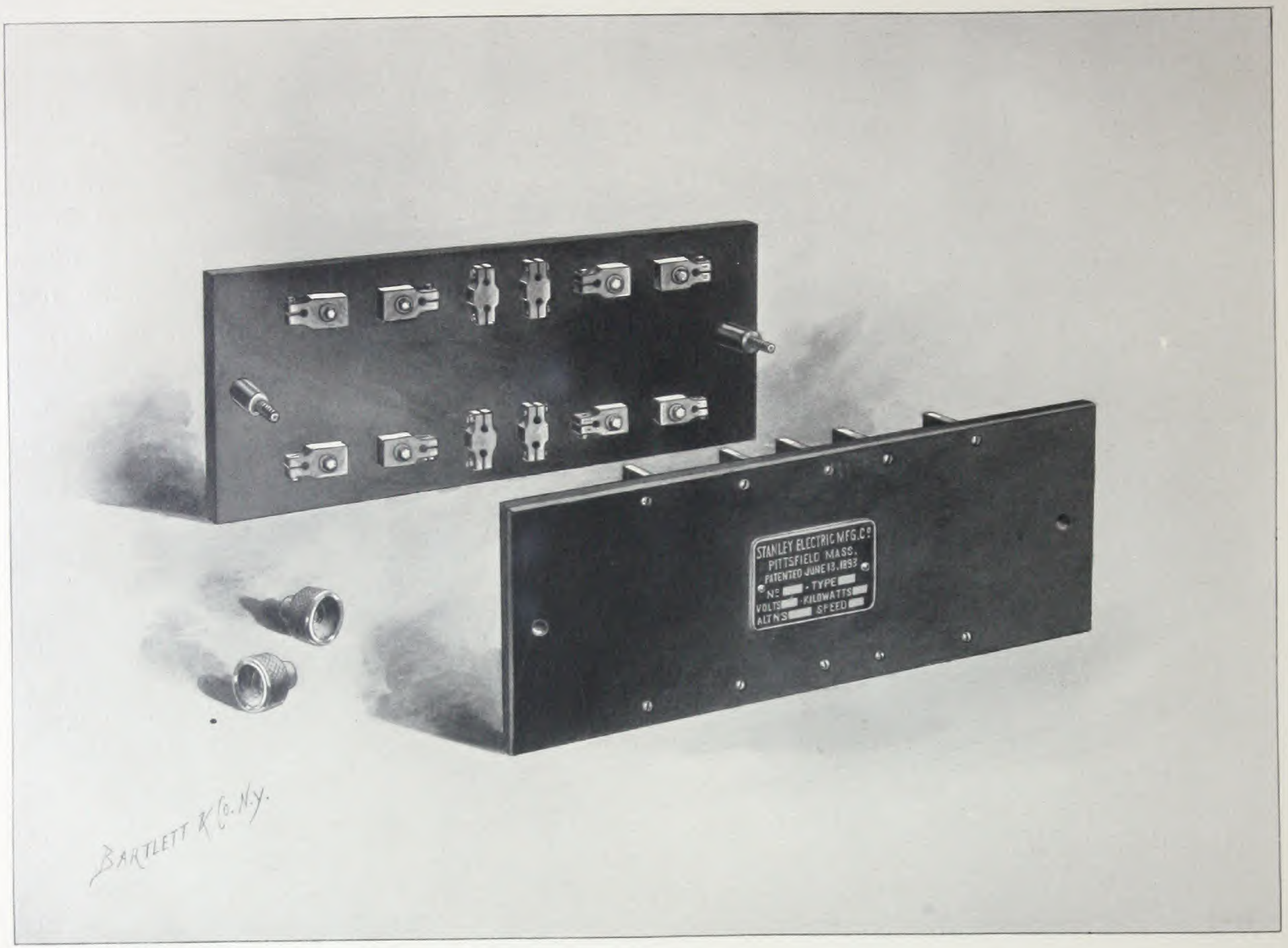
The Armature and Field Wires are brought out from the machine to a Terminal Board shown in the cuts on the machine and in detail in the cut on page 28, and from this terminal board the leads are taken out. With this arrangement no wires of any kind are shown festooned about the machine and everything is ship-shape and neat. The Terminal Board consists of two heavy slabs of marble, one secured to the machine and the other forming a removable cover. This cover on its inner face is divided into partitions so that, when in place, each Terminal is in a compartment by itself. It is so arranged that fuses may be inserted in the leads if desired as an extra precaution against short circuits. It is the most substantial, neat and convenient form of leading the wires out of a dynamo yet devised and is made possible by the entire absence of collector or commutator. By simply changing the connections on this Terminal Board the Armature Coils may be connected either in series or parallel, so that the standard machines may be connected for either 1000 or 2000 volts as desired.

THE FIELD COIL.

The Field or Exciting Coil is circular and wound on a copper spool which rests in the centre of the machine surrounding the Inductor. Constructed in this way it is easily insulated to a very high degree and, being enclosed on three sides by the heavy copper spool, danger of breaking down of the insulation due to a discharge, caused by a breaking of the field circuit when it is fully charged, is practically removed.

THE BASE.

The Base provided with each Generator is of iron and very substantial and, as shown in the cuts, is provided with a means of sliding the machine so as to tighten or loosen the belt at will.



TERMINAL BOARD.

ELECTRICAL ADVANTAGES.

The many mechanical and structural advantages of our Generator are at once evident upon examination, but it is no less remarkable in electrical performance.

EFFICIENCY.

The following table speaks for itself:

	60 K. W.	120 K. W.	240 K. W.
Efficiency at Full Load . .	94%	95%	96%
" " Half Load . . .	91%	93%	94%
" " Quarter Load . .	85%	88%	90%

No other alternating current dynamos, so far as we know, are nearly so efficient. These efficiencies we are willing to guarantee.

Having but one Exciting Coil, a degree of economy is obtained in the excitation of the machine which is not possible with the old fashioned type of Generators, and this Exciting Coil is so placed as to secure the best magnetic conditions. Steel and wrought iron laminations are used where other Generators are composed of cast iron. There being no moving wire it is safe to run our machine with a closer clearance than is advisable with the machines of other makes even of the toothed armature construction.

HEATING.

Our design also permits very readily of abundant ventilation so that it is the **Coolest Running** machine, not only because of its extraordinary efficiency but also because of its superior ventilation. The maximum rise in temperature above the surrounding atmosphere is not more than 50° F. in any part of the machine after a continuous run of twenty-four hours at full load.

REGULATION.

In no respect is our machine more decidedly superior than in its inherent regulation. So poor have alternating current dynamos been in this respect that all sorts of automatic methods of regulation have been tried and the one most commonly used is **compounding.**

We have proceeded on the theory that compounding in itself is an unquestioned disadvantage, as it complicates the generator and makes commutation necessary.

As the old fashioned alternating current generators, however, will not regulate within 30 or 40 per cent., compounding has become almost necessary and has therefore been extensively used.

Our Generator has an inherent regulation of from **5 per cent. to 8 per cent.,** depending on the size of the machine and the margin of E. M. F. desired on it.

A SAFE STATEMENT

is that with our Generators, the full load excepting one lamp can be thrown off instantly without materially increasing the brilliancy of the one remaining lamp (provided of course the speed of the machine is constant), and this is accomplished without any extraneous regulating device whatever.

Simplicity in a Central Station cannot be too highly valued, and all fussy automatic devices are unreliable and expensive to operate.

For a lighting company there is no better method of economizing than to put wire enough in its lines to keep the loss down to 2 per cent. with maximum load and then use generators with close inherent regulation. This insures the greatest simplicity and consequently the highest economy. It makes useless all collectors, commutators, regulators and other expensive and delicate devices, and not only reduces the cost of attendance and repairs, but makes possible more uniform and satisfactory service.

What possible advantage is there in compounding when two or more circuits, with 10 per cent. or more loss when fully loaded, are often supplied by a single generator at times when one of them may be fully loaded and the others half or quarter loaded. There is nothing logical in such engineering. It is the result of a mistaken idea of economy; an attempt to save a little in line construction.

All these difficulties may be done away with and all vexing problems of distribution solved by using a closely regulating machine and by being more liberal in the use of copper in the line. This liberality will pay for itself many times over by saving in operating expense; by saving the first cost of all sorts of devices (no longer necessary and which the manufacturers are furnishing at a fat profit) and by saving in repairs.

With our Generator, a line with a loss of 2 per cent., our Transformers and good secondary wiring, absolute simplicity and reliability is attainable. Before much money is made in Central Station lighting such a plan will have to be adopted. All other ways of endeavoring to give good service are makeshifts.

UNKNOWN BUT IMPORTANT.

It is not generally known that the shape of the current wave generated by a machine is of great importance in order to obtain the best economy in transformers and in the operation of motors by alternating currents. Some of the original types of alternators used in this country, with the surface wound armature, produced a very good form of wave, but the so-called toothed armature machines (now

adopted by all the principal manufacturers in order to obtain higher efficiency and less cost per unit of output) distort the wave so that instead of being in the form of a sine curve it is jagged and irregular.

In our Generator we obtain all the advantages of the toothed armature construction without this disadvantage. The poles, both on the Armature and Inductor, being stamped out of sheet iron by dies, are all exactly true and perfectly formed, and as the armature is stationary there is no need of overlapping teeth to hold the coils in place, consequently the form of the current wave produced by our machine is just what it ought to be theoretically, that is, a sine curve.

In operating motors commercially, this is of great importance as it permits of the more complete elimination of the false currents.

In the ordinary operation of lights it is important, because with a current of this character the energy lost in the iron of Transformers (core loss in watts) is about 10 per cent. less than with the form of current supplied by machines of other makes.

PARALLEL COUPLING.

If it is desirable to run alternators coupled in multiple it can be more easily accomplished with our Generator than with those heretofore used.

This is due to the fact that the poles on any two or more machines, both on Armature and Inductor, being necessarily exactly alike, the form of current wave must be the same from all the machines and coincide at all times. The remarkably close regulation of our Generators is also an important factor in this connection.

TO SUM UP

THE ADVANTAGES OF OUR GENERATOR ARE AS FOLLOWS:

FIRST.—Highest Efficiency.

SECOND.—Best Inherent Regulation.

THIRD.—No Moving Wire.

FOURTH.—No Collector or Commutator.

FIFTH.—Slow Speed.

SIXTH.—Coolest Running.

SEVENTH.—Generates a Correct Current Wave.

EIGHTH.—Least Liable to Burn Outs.

NINTH.—Easiest to Repair.

TENTH.—Cheapest to Repair.

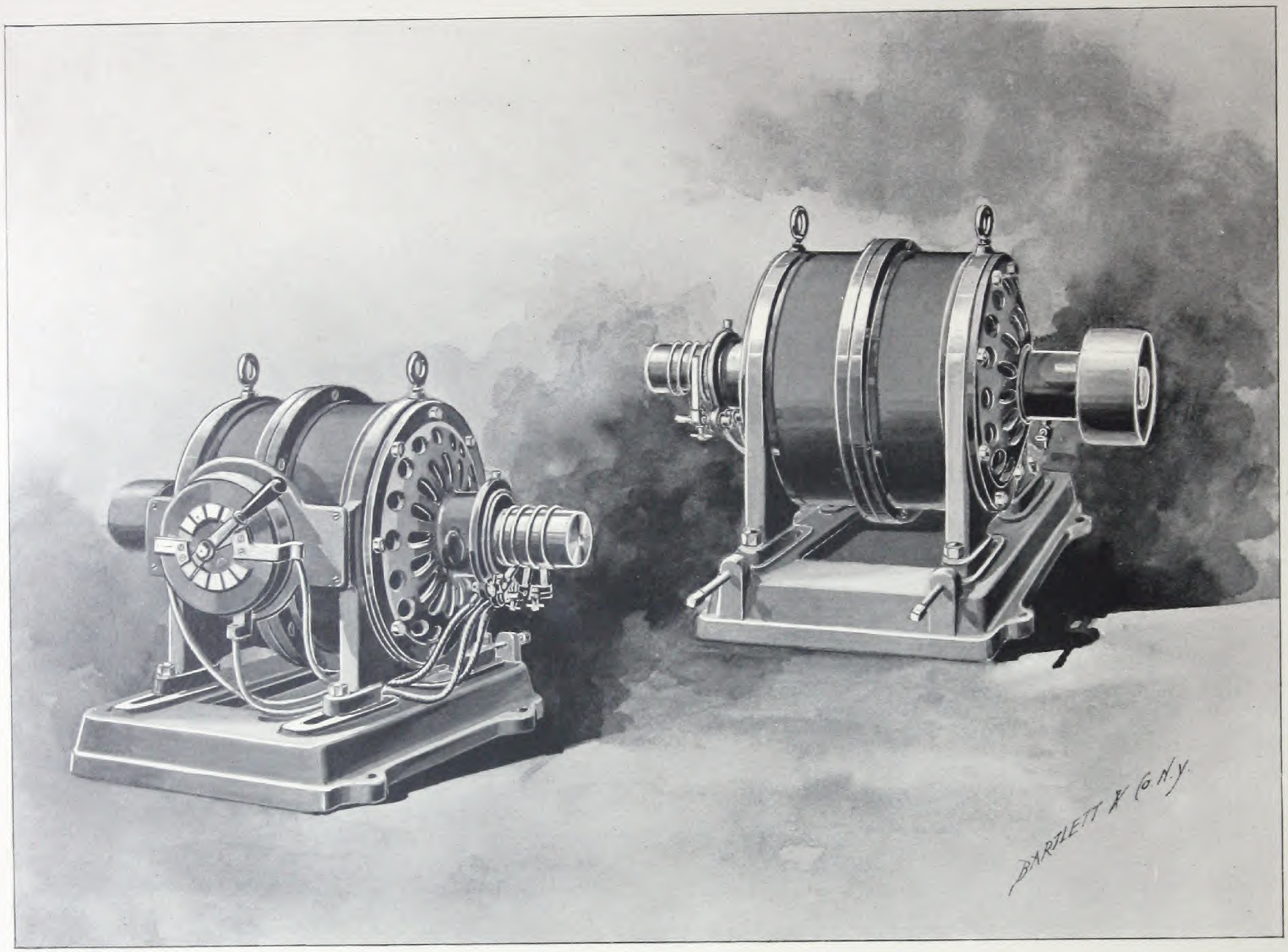
ELEVENTH.—Neatest in Appearance.

TWELFTH.—Most Mechanical.

THIRTEENTH.—Most Simple and Convenient.

FOURTEENTH.—Most Substantial.

FIFTEENTH.—It is decidedly novel and combines the result of all the experience of the past in alternating current generator construction, with the ripest knowledge of theory and the most brilliant appreciation of the direction in which improvement has been needed.



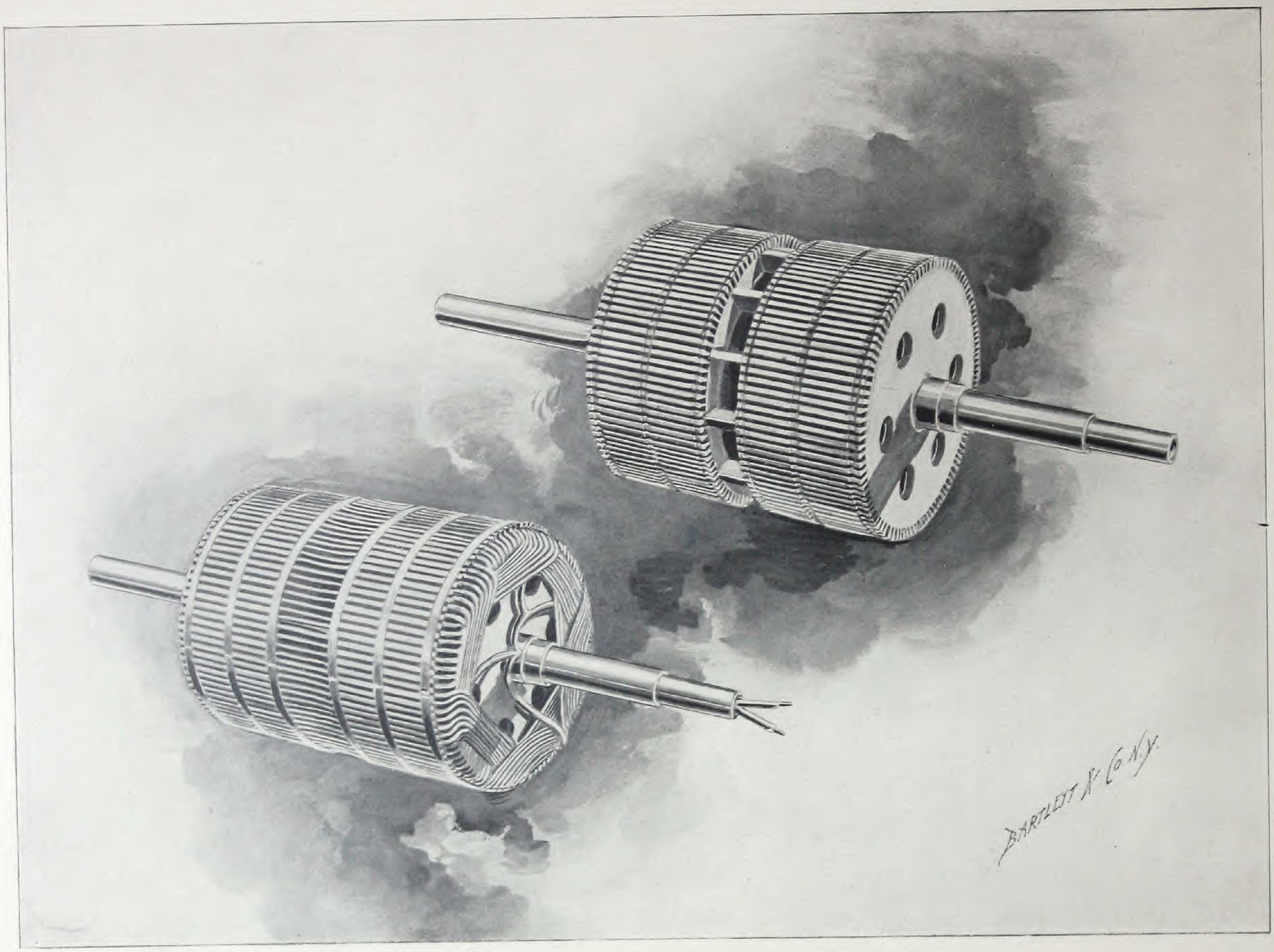
TWO PHASE MOTORS.

THE ALTERNATING CURRENT MOTOR.

The alternating current motor that shall fulfill the conditions imposed by commercial service must possess the following characteristics: It must start from any position of rest with a torque considerably greater than its running torque; it must maintain an approximately constant speed under maximum variations of load and its operation must not unduly disturb the potential of the system. The further qualities of simplicity of construction and operation and of efficiency in converting electrical energy into motive power are, of course, necessary.

It is thus evident that the various synchronous motors which have been adopted from time to time cannot fulfill these commercial requirements, for they can not start from rest with sufficient torque and there is therefore no reason for here discussing their characteristics or uses.

Alternating current motors of the so-called Tesla or any other type, either for single or multi-phase circuits, which have been so much talked about and experimented with, have not been commonly introduced heretofore, because of the false currents developed by such motors; the difficulty of making them with good starting torque without producing very excessive false currents, and the impossibility, because of these false currents, of producing a comprehensive system for both light and power fed by the same dynamo and circuits. These false currents have made regulation impossible because they react on and abnormally demagnetize the generator and transformers. They also would make necessary the



MOTOR ARMATURES.

use of generators, lines and transformers so disproportionately large for the work to be done that a system handicapped by them would be uncommercial. In a commercial system for distribution of light and power widely throughout a city, motors which take current about in proportion to their load are essential and the various multi-phase motors which there has been so much effort to introduce both here and abroad, have all failed in this particular.

Another reason why motors have not been introduced in this country has been because of the standard of frequency here adopted, at which frequency these false currents are much greater than with lower frequencies and their disturbing features more difficult to overcome.

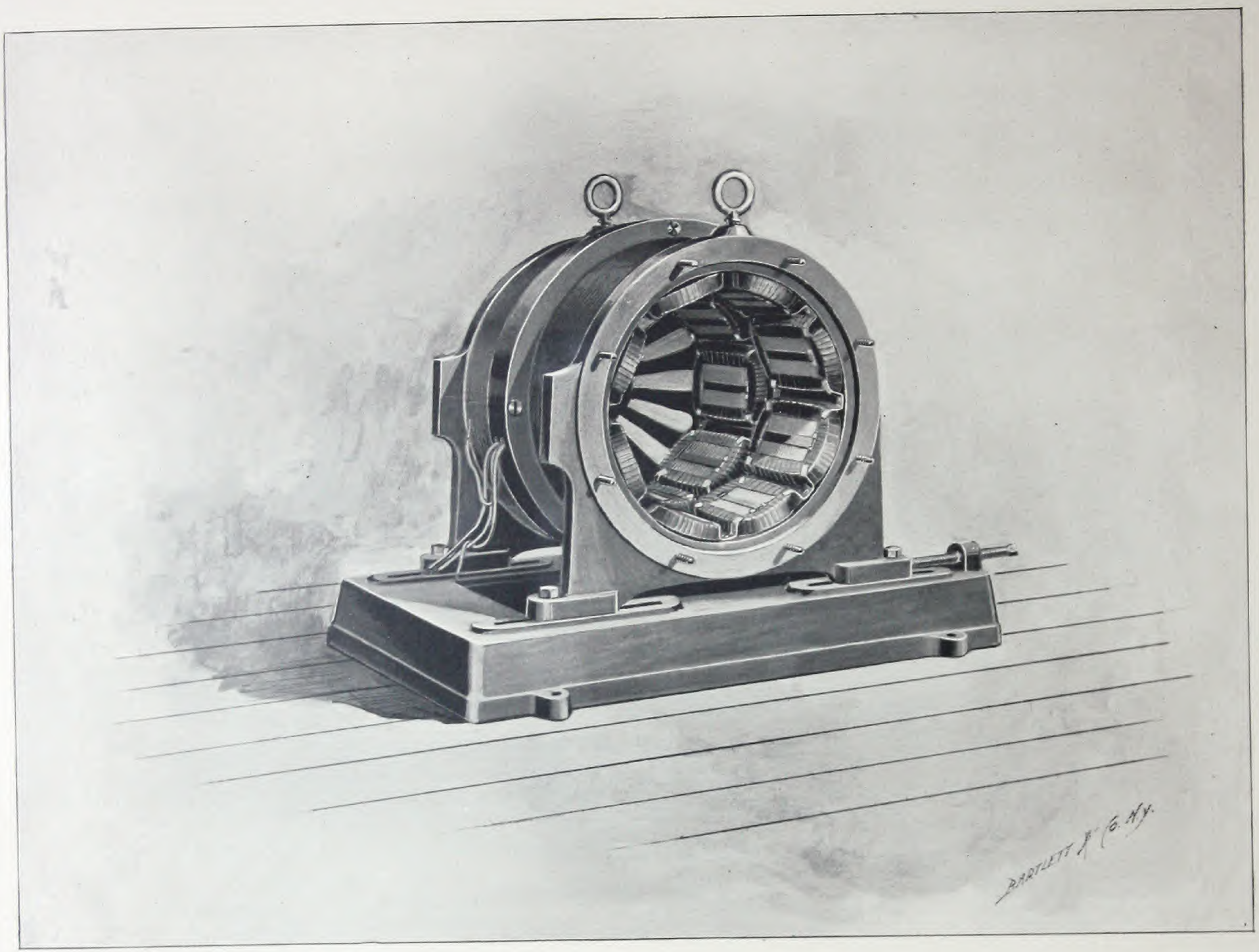
One object of the Stanley Company has been to produce a motor which would be commercial on the standard frequencies used in this country in order to, in a great many places, simplify the problem of adopting multi-phase apparatus because of the vast amount of money already invested in generators and transformers only adapted for this high frequency.

OUR TWO PHASE MOTOR.

The "S. K. C." Motor is novel and its principle of operation is entirely distinct from the so-called rotary field types of motor, such as the Tesla. In it there is no attempt to combine the influences of two sets of alternating current magnets in order to produce a rotating magnetic field. This motor may be best described as consisting of two parts, a motor proper and a rotating transformer, the two parts alternately exchanging their functions.

It consists electrically of two fields, which are fed by currents differing 90° in phase, and two armatures, though mechanically there is but one, as shown by the cuts.

The winding is so connected that the wire which lies directly under poles on one armature is in series with the wire lying between poles on the other. It is clear that in this position one half the machine acts as transformer and the other half as motor.



MOTOR FIELD.

THE MOTOR ARMATURE

is shown wound and unwound, in the cuts on page 36. The armature winding is not connected with the circuit and consequently the only current flowing in it is an induced current.

THE FIELD

construction is accurately shown in the cut on page 38. The coils are wound separately and then secured in place. These coils are the only part of the motor connected with the circuit. Being stationary they are easily insulated to a high degree. The applied E. M. F. on the coils is 500 volts.

The cut on page 38 also shows what we term the "compensating winding," which consists of short circuited coils of high conductivity placed in the field poles for the purpose of neutralizing the self induction of the armature. This construction increases the

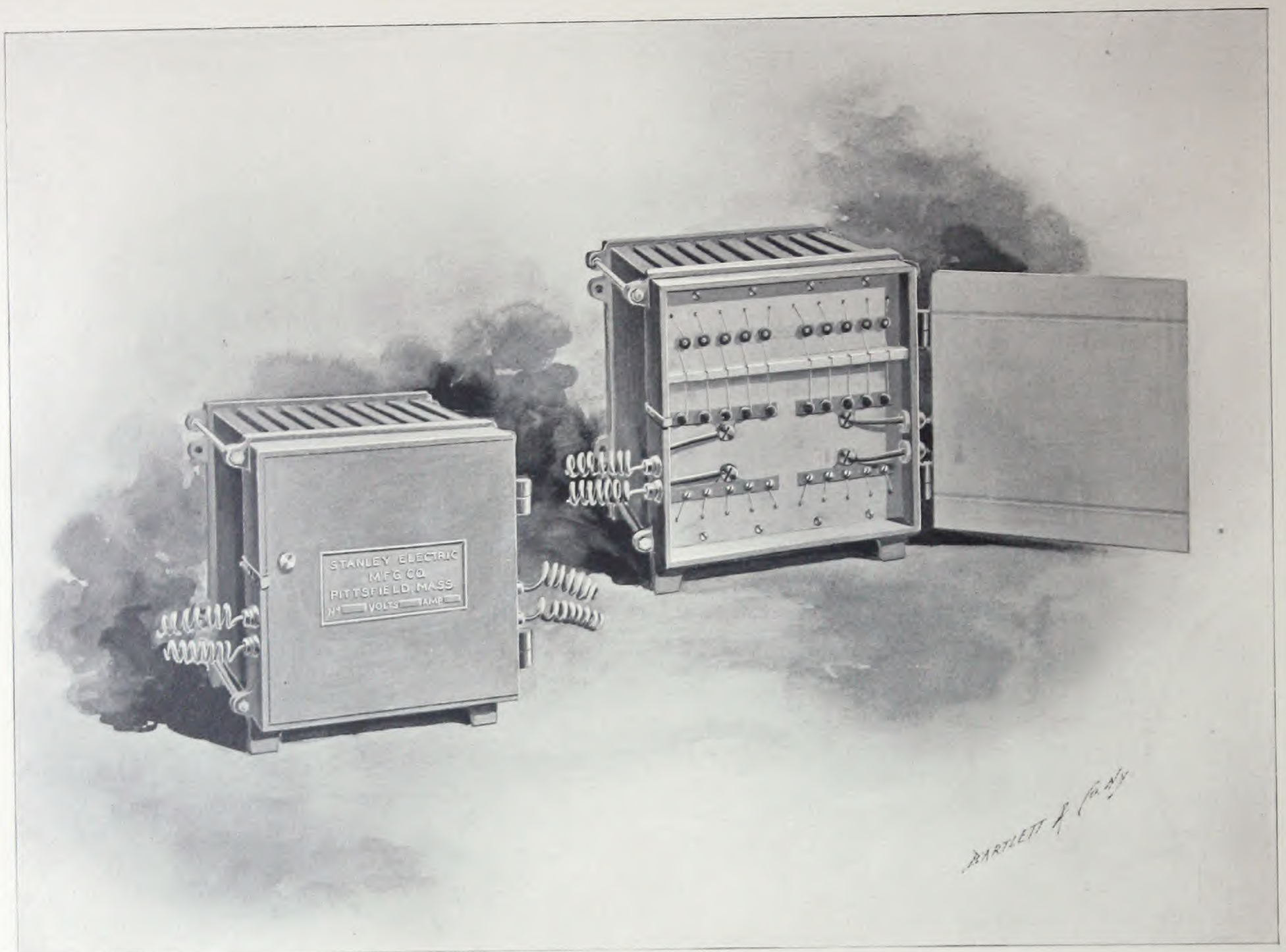
STARTING TORQUE

of the motors so that we obtain in the standard motors of different sizes, at starting, a torque which varies from 50 to 200 per cent. greater than the running torque at full load. This is a very ingenious invention and one of great importance in induction motors and is covered by a broad patent issued to Messrs. Stanley and Kelly.

CONDENSERS.

The most unique and striking feature of this motor system is the use of the Condenser, which is broadly covered by the patents under which we manufacture.

The function of the condenser is to make the motor take current in proportion to its load substantially as direct current motors do, and they accomplish the result so perfectly as to make commercial what has heretofore been only experimental.


STANLEY ELECTRIC
MFG. CO.
PITTSFIELD, MASS
No. VOLTS AMP.
BARTLETT & Co. Lith.

CONDENSERS.

The condensers in commercial form are shown in the cuts on page 40.

They are connected in multiple with the fields of the motor, as shown in the diagram on page 54.

When so placed they supply the lagging component of the current, or, in other words, the false current.

Thus with this arrangement the false currents, instead of flowing back through the transformer line and generator, thereby disturbing the whole system, simply flow in a local circuit through the condensers. This is why our motor system is successful where others have failed, as it enables us to operate alternating current motors and lights successfully from the same generator and circuit. Without condensers alternating current motors can not be operated on the same circuit with lights on currents of high enough frequencies to meet other commercial conditions.

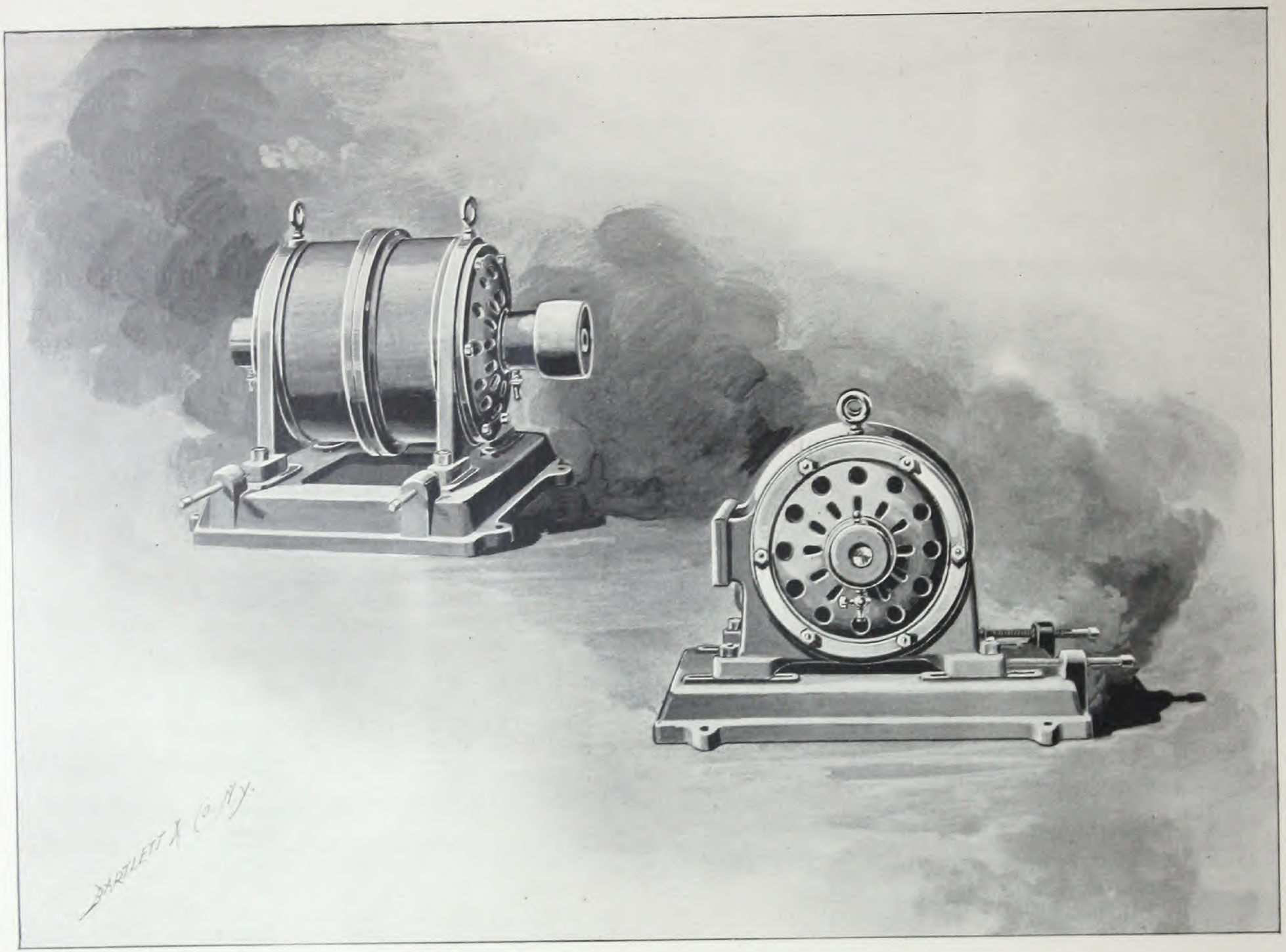
There is no other Company which even claims to have motors for currents of 15,000 or 16,000 alternations, nor do we know of any other motor which is being or can be successfully operated on currents of even 7000 or 8000 alternations and permit of lighting service from the same circuit at the same time.

THE CONDENSER IN USE

is no trouble and does not complicate the system. When once set up in place there is nothing to do to it, being like a transformer in this respect.

Much study has been given by us for the past two years to the manufacture of condensers, for commercial use with our Motors, with the result that they are now thoroughly reliable and inexpensive.

The manufacture of condensers for such use is practically a new art and its perfection a decided triumph.



SMALL TWO PHASE MOTORS.

EFFICIENCY OF MOTORS.

Our two phase Motors are very efficient, about the same in this respect as direct current motors. In the larger sizes it reaches 90 per cent. and falls off gradually to 80 per cent. in the 5 H. P. and 70 per cent. in the 1 H. P.

These are the figures of actual efficiency as obtained by measurements with a watt meter and not by volt-ampere readings.

Taking volt-ampere readings as a basis of calculation gives the apparent efficiency, as it includes the false currents which still exist to some extent even with the condensers in use, though they are no longer a serious disturbing factor. To illustrate: the real efficiency of a 15 H. P. motor is 85 per cent., whereas the apparent efficiency is only 75 per cent. It is well understood that this difference does not represent energy, but simply a "wattless" current, which when reduced to this small proportion, does no practical harm.

REGULATION.

Our Motors in this respect are remarkably good, the variation in speed between running light and fully loaded being from 6 per cent. to 10 per cent. in the various sizes.

OVERLOADING.

All alternating current motors have one advantage in that they will not keep on running with heavy overloads till they burn up, as direct current motors will, but when loaded beyond a certain point will simply refuse to go on. Where power is rented on a contract basis this is of great advantage to the central station, as it will in a measure prevent the stealing of power. Another advantage of this is that purchasers of motors must buy sizes properly adapted for the work they will be called on

to do. This does not mean that a sudden heavy overload, such as often occurs in starting and at other times in some classes of work, is going to stop the motor, but that before burning out on a continuous excessive overload they will stop. Our Motor will carry continually an overload of 25 per cent. with a reduction in speed, from full load speed, of only 2 per cent., and will not slow down so as to be inoperative with less than 50 per cent. continual overload. It must not be argued from this, however, that it is any better judgment to overload this Motor than any other piece of machinery. Deliberate overloading is always bad policy and expensive in the long run.

PRACTICAL USE.

Every day for a year and a half past these Motors in various sizes have been used in Pittsfield on two phase circuits from the central station of the Pittsfield Electric Co. This has given us an opportunity to observe their performance on various classes of work and satisfy ourselves about them in all respects by their practical commercial operation instead of by laboratory tests.

These Motors have been running Machine Shops, Planing Mills, Printing Presses, Elevators, Wood-working Machinery, Carding Machines, etc., etc., and have consequently been subjected to trying conditions and in no single case have they failed to give complete satisfaction, and never once has a motor failed to perform its work continually without any trouble or attention except an occasional oiling.

These facts constitute a firm basis for our claim that we have a practical Motor and it is the only alternating current Motor that we know of which has been demonstrated to be practical by commercial use.

THE STARTING BOX.

On the side of the Motor in the cut on page 34 is shown the Starting Box. When the switch is closed to start the Motor, the handle of this box is at the left hand when facing it, and as the motor reaches its full speed, it is thrown clear over to the right. When in this position the resistance

in the box is cut out, so that it is in circuit only for a moment when starting. The Collector on the Motor is for the purpose of putting the resistance in this box in circuit with the Armature when starting and when the Motor is up to speed, and the resistance cut out, it performs no further function.

The cuts on page 42 show the Motor in small sizes without the Starting Box. For many uses of small Motors so little starting torque is required that the box would be an unnecessary adjunct.

COMPARISON

with direct current motors is most favorable to our two phase Motor.

It is much more simple. . . . . .

Has no commutator. . . . . .

Is much less liable to burn out. . .

Requires no attention when running.

DESIGN AND WORKMANSHIP.

The design of these motors is neat and compact. The workmanship on them is of the best. The bearings are of the most approved self oiling type. No pains are spared by us to make them first class in every respect and fully up to the high standard of our Generators and Transformers.

SIMPLICITY AND CONVENIENCE.

There is no direct current motor so simple and therefore so convenient to use.

There is absolutely nothing on the motor to be adjusted or fussed with, and the absence of the commutator makes it perfectly reliable. All that is necessary is an occasional supplying of the self oiling bearings with a proper lubricant.

In fact these motors can, with perfect safety, be put off in a corner somewhere and allowed to take care of themselves.

They can be used in many places where direct current motors can not be, because of the danger from commutator sparks setting fire to combustible materials. They can also be located in inaccessible places and started at some convenient point.

SUMMARY.

Our Generator, Motor and Transformer, all of them unequalled in many particulars, supplement each other when combined so as to make a more perfect, useful and simple system than any heretofore introduced.

We ask the most careful inspection of our apparatus, and court comparison of it with anything on the market. We are prepared to make the following

GENERAL GUARANTEES.

That with our system the throwing on or off of motors at any point on the line will not more seriously affect the voltage or steadiness of the lights than the throwing on or off of the same amount of power in lights.

That there is no greater necessity for maintaining an equal load on the two circuits from one two phase machine than there would be if they were two independent circuits supplied by one single phase generator.

The meaning of these general guarantees is that the service of lights from our two phase system under the usual conditions of operation, with motors and lights on the same generator and circuit, will be as satisfactory as light service from the ordinary single phase system on which no motors are used, provided the engineering conditions as to steadiness of power, loss in line, etc., are the same.

DIAGRAM NO. 1. FOR ORDINARY LOCAL SERVICE.

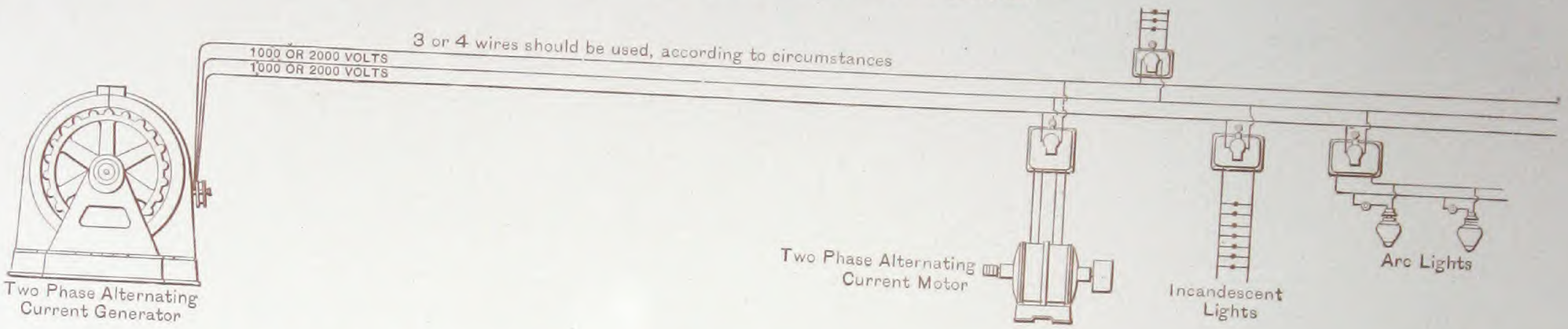


DIAGRAM NO. 2. FOR LONG DISTANCE TRANSMISSION; USING HIGH VOLTAGE GENERATOR AND STEP DOWN TRANSFORMERS.

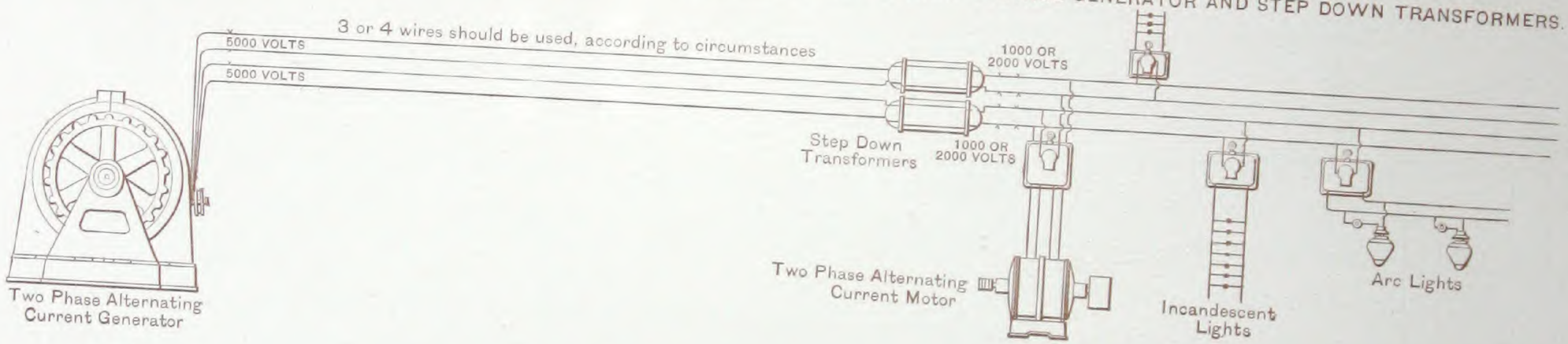
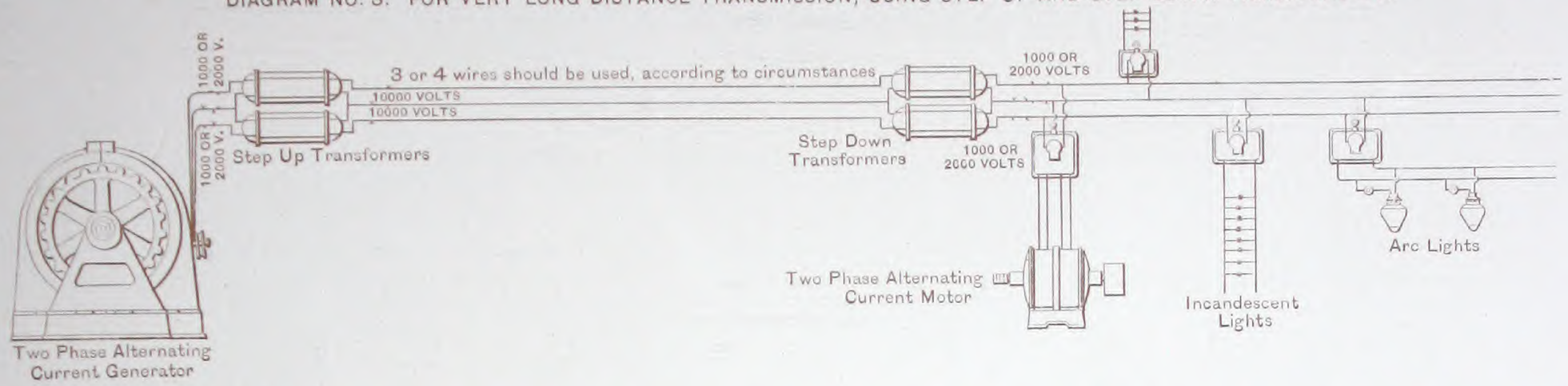


DIAGRAM NO. 3. FOR VERY LONG DISTANCE TRANSMISSION, USING STEP UP AND STEP DOWN TRANSFORMERS.



The three accompanying diagrams, showing methods of wiring for the two phase system, will be understood at a glance. Wherever two phase motors are used, connection is made with all three or four wires, as the case may be, and the motor takes current equally from both circuits or phases. Where either incandescent or arc lights are used the transformer is connected to only one circuit or phase. In practice, therefore, in order to utilize the full power of the generator, the lighting transformers should be about equally divided between the two circuits or phases. Such a balance is not, however, necessary in order to give good service, as one circuit has no effect on the other and one may be run fully loaded and the other with no load.

As our form of generator enables us to build them to safely deliver very high potentials, the necessity of step up transformers is removed in long distance transmission plants where not more than 5000 volts are desired. This not only means a considerable saving over other systems in first cost, but also increased economy of transmission and better regulation. This is an important point, as for distances of less than ten miles it is seldom desirable to use more than 5000 volts.

LONG DISTANCE WIRING TABLE—STANLEY ELECTRIC

THE FIGURES AT THE TOP OF EACH COLUMN INDICATE THE DROP IN VOLTS.
THE FIGURES BELOW INDICATE SIZE OF WIRE IN CIRCULAR MILLS (= D^2).

THE FIGURES AT T
THE FIGURES BELO

20	25	30	40	50	60	70	80	100	125	150	200	1	2	3	4	5	6	8	10	12	
				1000000	833300	714300	625000	500000	400000	333330	250000	2357200	1178600	785600	589300	471440	392800	294600	235720	196400	
	1000000	833330	625000	500000	416665	357150	312500	250000	200000	166660	125000	1178600	589300	392800	294650	235720	196400	147300	117860	98200	
1000000	800000	666640	500000	400000	333330	285720	250000	200000	160000	133330	100000	942880	473440	314240	236720	188576	157120	119440	94288	78560	
750000	600000	499980	375000	300000	249990	214290	187500	150000	120000	99990	75000	707160	353560	235680	176780	141432	117840	88380	70716	58920	
529000	423200	352666	269500	211600	176333	151143	134750	105800	85650	70533	52900	498860	249430	166280	124715	99772	83144	62358	49886	41572	
500000	400000	333330	250000	200000	166660	142860	125000	100000	80000	66660	50000	471440	235720	157120	117860	94288	78560	58920	47144	39280	
419510	335610	279672	209755	167805	139836	119860	104878	83902	67122	55935	41951	395580	197790	131860	98895	79116	65930	49448	39558	32965	
332695	266158	221796	166348	133079	110898	95056	83174	66539	53232	44359	33269	313710	156855	104570	78428	62742	52285	39214	31371	26142	
263835	211168	175890	131918	105534	87945	75381	65959	52767	42254	35178	26383	243600	121800	81200	60900	48720	40600	30450	24360	20300	
250000	200000	166660	125000	100000	83330	71430	62500	50000	40000	33330	25000	235720	117860	78560	58930	47144	39280	29460	23572	19640	
225000	180000	149994	112500	90000	74997	64287	56250	45000	36000	29999	22500	212130	106065	70704	53032	42426	35352	26514	21213	17676	
209485	167388	139656	104742	83694	69828	59853	52371	41897	33478	27898	20948	197300	98650	65766	49375	39460	32883	24688	19730	16442	
200000	160000	132228	100000	80000	66666	57144	50000	40000	32000	26666	20000	188560	94280	62848	47140	37712	31424	23568	18856	15712	
175000	140000	116662	87500	70000	58331	50000	43750	35000	28000	23333	17500	174990	87495	54992	43797	34998	27496	20622	17499	13748	
165930	132746	110620	82965	66373	55310	47408	41482	33186	26549	22124	16593	156470	78235	52158	39118	31294	26079	19559	15647	12039	
150000	120000	99996	75000	60000	49998	42858	37500	30000	24000	19999	15000	141440	70720	47136	35360	28288	23568	17676	14144	11844	
131585	105268	87724	65792	52634	43862	37596	32896	26317	21054	17545	13158	124080	62040	41360	31020	24816	20680	15510	12408	10340	
125000	100000	83330	62500	50000	41665	35715	31250	25000	20000	16666	12500	117860	58930	39280	29465	23572	19640	14730	11786	9820	
104360	83486	69562	52180	41743	34786	29817	26090	20872	16697	13914	10436	98400	49200	32800	24600	19680	16400	12300	9840	8200	
100000	80000	66666	50000	40000	33333	28572	25000	20000	16000	13333	10000	94280	47140	31424	23570	18856	15712	11784	9428	7856	
82755	66204	55170	41378	33102	27585	23644	20689	16551	13241	11034		78030	39015	26010	19000	15606	13000	9504	7803	6500	
75000	60000	49998	37500	30000	24999	21429	18750	15000	12000	9999		70720	35360	23568	17680	14144	11780	8838	7072	5892	
65625	52500	43750	31812	26250	21875	18744	15906	13125	10500			61880	30940	20626	15470	12376	10313	7735	6188	5156	
52050	41640	34700	26025	20820	17350	14871	13012	10410				49080	24540	16360	12270	9816	8180	6135	4908	4090	
50000	40000	33333	25000	20000	16666	14286	12500	10000				47140	23570	15712	11785	9428	7856	5892	4714	3928	
41275	33020	27516	20638	16510	13758	11793	10319					38870	19435	12957	9718	7774	6478	4859	3887	3239	
32730	26184	21820	16365	13092	10910							30860	15430	10287	7715	6172	5144	3858	3086	2572	
25960	20768	17306	12980	10384								24470	12235	8157	6118	4894	4078	3059	2447	2039	
25000	20000	16666	12500	10000								23570	11785	7856	5892	4714	3928	2946	2357	1964	

MANUFACTURING CO.

OP OF EACH COLUMN INDICATE THE CURRENT IN AMPERES.
DICATE THE DISTANCES IN FEET TO CENTRES OF DISTRIBUTION.

	16	18	20	25	30	35	40	45	50	55	60	65	70	75	80	90	100
0	147300	130900	117860	94300	78600	67300	58930	52400	47100	42800	39300	36300	33700	31400	29400	26200	23500
0	73650	65450	58930	47150	39300	33650	29465	26200	23550	21400	19650	18150	16850	15700	14700	13100	11750
0	58920	52360	47144	37720	31440	29620	23572	20960	18840	17120	15720	14520	13480	12560	11786	10480	9400
0	44190	39270	35358	28290	23580	20205	17679	15720	14130	12840	11490	10890	10100	9420	8839	7860	7050
7	31179	27714	24943	19952	16628	14253	12472	11086	9976	9070	8314	7675	7126	6650	6236	5543	4988
0	29460	26180	23572	18860	15720	13460	11786	10480	9420	8560	7860	7260	6740	6280	5893	5240	4700
0	24724	21976	19779	15820	13186	11300	9889	8790	7910	7191	6593	6086	5651	5273	4944	4395	3955
8	19607	19428	15686	12548	10458	9863	7843	6972	6274	5700	5229	4826	4931	4183	3921	3486	3137
0	15225	13533	12180	9744	8120	6960	6090	5414	4872	4430	4060	3748	3480	3248	3045	2700	2436
0	14730	13090	11786	9430	7860	6730	5893	5240	4710	4280	3930	3630	3370	3140	2940	2620	2350
7	13257	11781	10607	8487	7074	6057	5300	4716	4239	3852	3537	3267	3033	2826	2652	2358	2115
3	12344	10961	9865	7892	6576	5636	4932	4384	3946	3587	3288	3035	2818	2630	2466	2192	1973
4	11784	10472	9428	7544	6288	5384	4714	4192	3768	3424	3144	2900	2696	2512	2357	2096	1880
1	10311	9163	8749	6600	5500	4711	4375	3668	3297	2996	2751	2551	2359	2198	2187	1834	1645
6	9779	8693	7824	6258	5216	4470	3912	3478	3129	2845	2608	2400	2235	2086	1956	1739	1564
8	8838	7854	7072	5658	4716	4038	3536	3144	2826	2568	2358	2178	2022	1884	1768	1572	1410
3	7755	6871	6204	4960	4136	3545	3100	2758	2480	2256	2068	1852	1772	1653	1551	1379	1240
5	7365	6545	5893	4715	3930	3365	2947	2620	2355	2140	1965	1815	1685	1570	1474	1310	1175
0	6130	5484	4920	3936	3280	2811	2460	2186	1968	1790	1640	1514	1405	1312	1230	1093	984
2	5892	5236	4714	3772	3144	2692	2357	2096	1884	1712	1572	1452	1348	1256	1179	1048	940
3	4752	4335	3902	3120	2600	2229	1951	1734	1560	1418	1301	1200	1114	1040	975	867	780
9	4419	3927	3536	2829	2358	2019	1768	1572	1413	1284	1149	1089	1011	942	884	786	705
0	3868	3438	3094	2474	2062	1768	1547	1374	1237	1125	1031	952	884	825	773	687	618
6	3068	2727	2454	1962	1630	1400	1227	1086	981	982	815	755	701	654	613	543	
6	2946	2618	2357	1886	1572	1346	1179	1048	942	856	786	726	674	628	589		
6	2429	2160	1944	1554	1296	1110	972	864	777	707	648	598					
4	1929	1714	1543	1234	1028	882	772	686	617								
8	1529	1360	1224	978	816	699	612	544									
3	1473	1300	1178	943	786	673	589										

FOR TWO PHASE DISTRIBUTION.

I. Determine the total amperes per phase (one-half total capacity of machine).

II. From the accompanying table determine the size of wire for any given distance for the number of amperes per phase; this will be the size of each of the two outside wires.

III. The middle wire should be 41 per cent. larger in cross section than one of the outside wires.

IV. If four wires are used instead of three all should be of the same size as determined by II.

NOTE:—In cases of transmission of heavy currents over long distances, the question of Inductance in the line becomes very important. In the accompanying table Inductance has not been considered. Before determining sizes of wires in such cases, therefore, competent authorities should be consulted. We hold ourselves in readiness to give information on this subject when requested.

TABLE OF SIZES AND CORRESPONDING WEIGHTS.

Size No. B. & S. Gauge.	Diameter Base in Inches.	Circular Mills.	Weight in lbs. per 1000 ft.		Weight in lbs. per mile.		Safe Carrying Capacity at 1000 Amperes per sq. in.
			Base.	Insulated Weather Proof Line Wire.	Base.	Insulated Weather Proof Line Wire.	
0000	.460	211600	639	826	3375	4361	166
000	.40964	167805	507	611	2677	3226	131
00	.36480	133079	402	460	2123	2429	104
0	.32495	105534	319	367	1734	1938	82
1	.28930	83694	252	292	1335	1542	65
2	.25763	66373	200	242	1058	1278	52
3	.22942	52634	159	192	839	1014	41
4	.20431	41743	126	160	665	845	33
5	.18194	33102	100	136	528	718	26
6	.16202	26250	79	111	418	586	21
7	.14428	20820	62	73	332	385	16
8	.12849	16510	48	48	258	253	13
9	.11443	13092	39	32½	208	172	10
10	.10189	10384	31	22	165	116	8

STANDARD BELT DRIVEN TWO PHASE A. C. GENERATORS.

KILOWATTS	H. P.	Speed Revolutions Per Minute	Pulley		Space Occupied			Weight Complete Pounds
			Diameter Inches	Face Inches	Length	Width	Height	
60	80	1000	24	12	6′–0″	5′– 0″	4′– 3″	6900
120	160	800	30	18	7′–0″	5′–11″	4′–11″	10300
240	320	400	54	28	13′–3″	7′–10″	7′– 5¾″	28000
350	470	365	60	42	14′–4¾″	8′– 6″	8′– 5⅝″	38000

These standard sizes of generators are built regularly for a frequency of either 16000 or 8000 alternations per minute, and are wound so that any machine may be connected up for 1000 or 2000 volts, as desired.

The same generators will be wound for any pressure up to 5000 volts where wanted for long distance transmission.

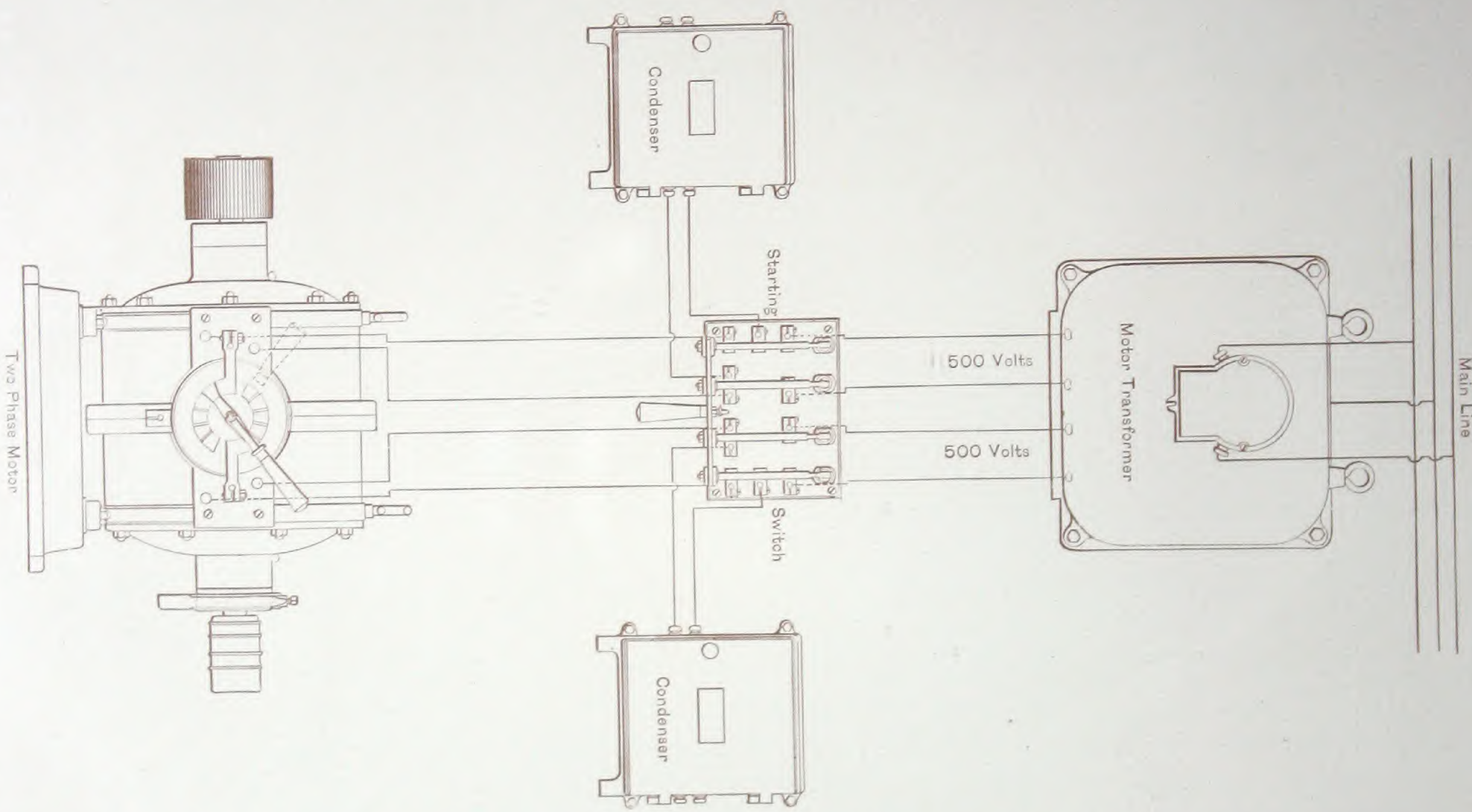
Generators for any frequency other than standard, or for direct connection, will be built to order

Larger sizes than given in the above table will also be built to order for any speed or any frequency.

STANDARD TWO PHASE A. C. MOTORS.

H. P.	Speed Revolutions Per Minute	Pulley		Space Occupied			Weight Complete Pounds
		Diameter Inches	Face Inches	Length	Width	Height	
1	2400	3	2⅛	2′– 1″	1′– 8″	1′–4½″	246
2	2400	4	2½	2′– 4″	1′–10″	1′–6½″	330
3	1840	5	3¾	2′– 9″	2′– 8″	2′–0″	540
5	1850	6	4	3′– 1″	3′– 0″	2′–2″	820
7	1840	6	4	3′– 6″	3′– 2″	2′–4″	1276
10	1500	8	5	3′– 6″	3′– 6″	2′–7″	1250
15	1500	10	6¼	3′–10″	4′– 1″	2′–9″	1518
20	1280	15	8½	4′– 6″	4′–10″	3′–4″	2100
30	1280	15	8½	4′– 6″	5′– 0″	3′–4″	2900
40	1280	15	10½	4′–11″	5′– 6″	3′–8″	3600
50	1280	15	10½	4′–11″	5′– 9″	3′–8″	4200

These standard sizes of motors are built for either 16000 or 8000 alternations.
We are prepared to furnish to order larger motors up to 500 H. P.



DIAGRAM, SHOWING CONNECTION WITH PRIMARIES OF TWO PHASE TRANSFORMER, CONDENSER AND MOTOR.

WIRING TABLE FOR TWO PHASE A. C. MOTORS.

USING 500 VOLTS AND FOUR WIRES FROM TRANSFORMER.
TWO PER CENT. LOSS.

SIZE OF MOTORS	DISTANCE IN FEET FROM TRANSFORMER TO MOTOR																	
	25	50	75	100	125	150	175	200	250	300	350	400	500	600	700	800	900	1000
	SIZE OF WIRE B. & S. GAUGE																	
1 H. P.	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
2 "	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
3 "	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
5 "	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	11	11	10
7 "	12	12	12	12	12	12	12	12	12	12	12	12	11	11	10	9	9	8
10 "	11	11	11	11	11	11	11	11	11	11	11	11	10	9	8	8	8	7
15 "	11	11	11	11	11	11	11	11	11	10	10	9	8	7	7	6	5	5
20 "	10	10	10	10	10	10	10	10	10	9	8	8	7	6	5	5	4	4
30 "	8	8	8	8	8	8	8	8	8	7	7	6	5	4	4	3	2	2
40 "	5	5	5	5	5	5	5	5	5	5	5	5	4	3	2	2	1	1
50 "	4	4	4	4	4	4	4	4	4	4	4	4	3	2	1	1	0	0

NOTE:—In no case use smaller size of wire than shown in table.

TRANSFORMERS.

Our Transformer is too well known to require a detailed description here. Having made a specialty of transformer manufacture for the past three years and given this subject the most careful study, both from a scientific and practical standpoint, we feel that we are warranted in stating that we to-day furnish the best transformer made.

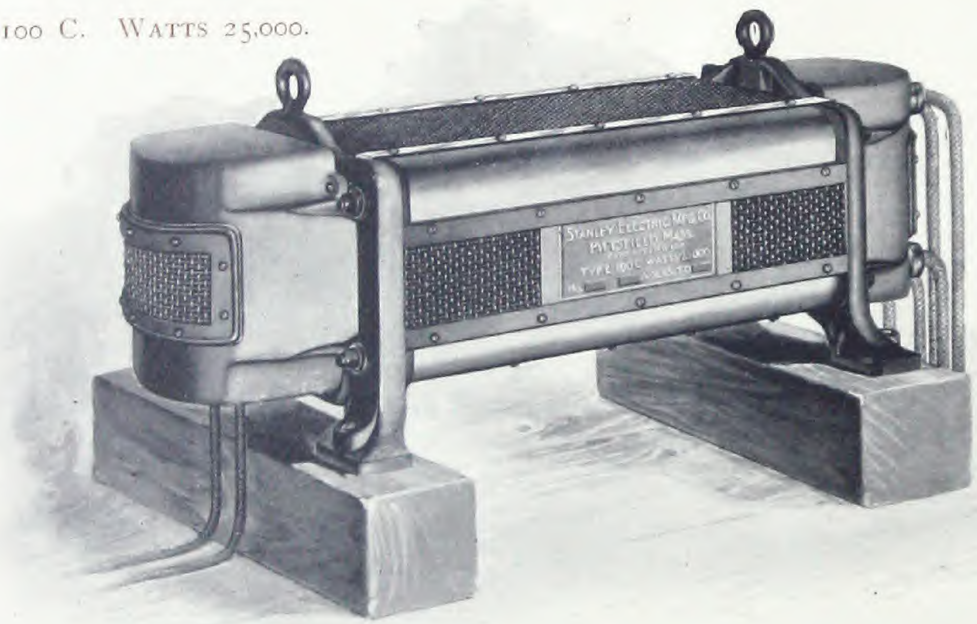
First cost is an important, but by no means the most important consideration in selecting a transformer, as economy of operation must be obtained in order to make money in the business of renting light and power. Our Transformer is the cheapest when this is considered.

We have to-day more than 500,000 lights capacity of Transformers in use in the United States, and the satisfaction they give is the best proof of our claims.

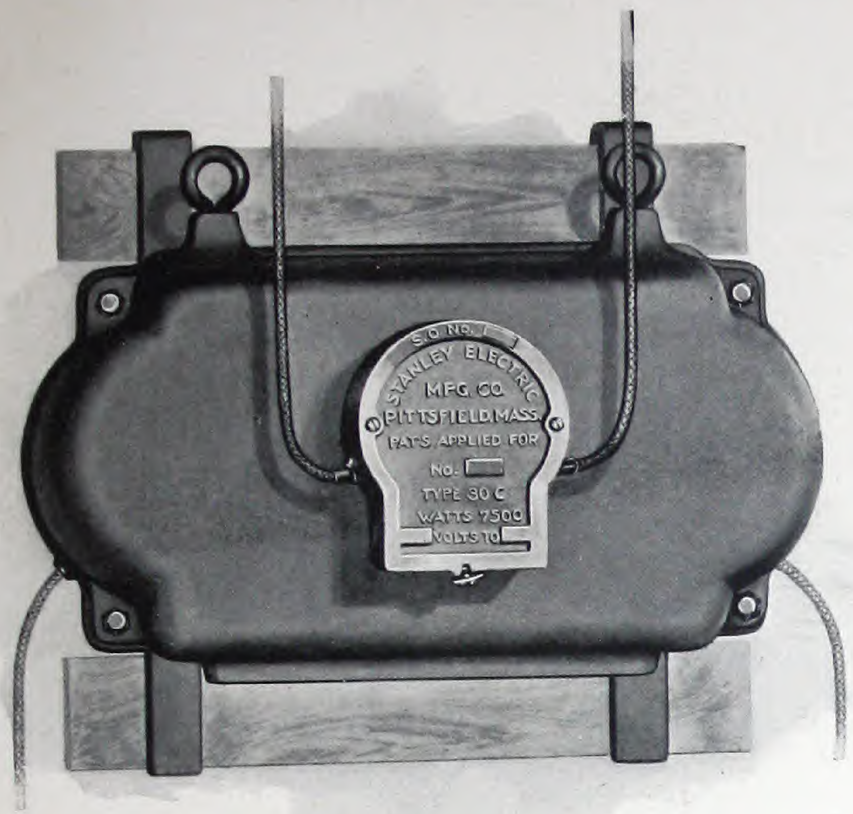
In long distance transmission and power work the transformer assumes even more importance than heretofore in ordinary incandescent lighting service, and our long experience in designing and making large transformers, of high voltages and for special uses, enables us to complete our two phase system by a much better and more complete line of transformers than can be obtained elsewhere.

To anyone desiring a more detailed description of our Transformer we will send a pamphlet describing same on application.

TYPE 100 C. WATTS 25,000.



INDOOR TYPE.



OUTDOOR TYPE.

LIST OF SIZES.

STANDARD INCANDESCENT TRANSFORMERS.

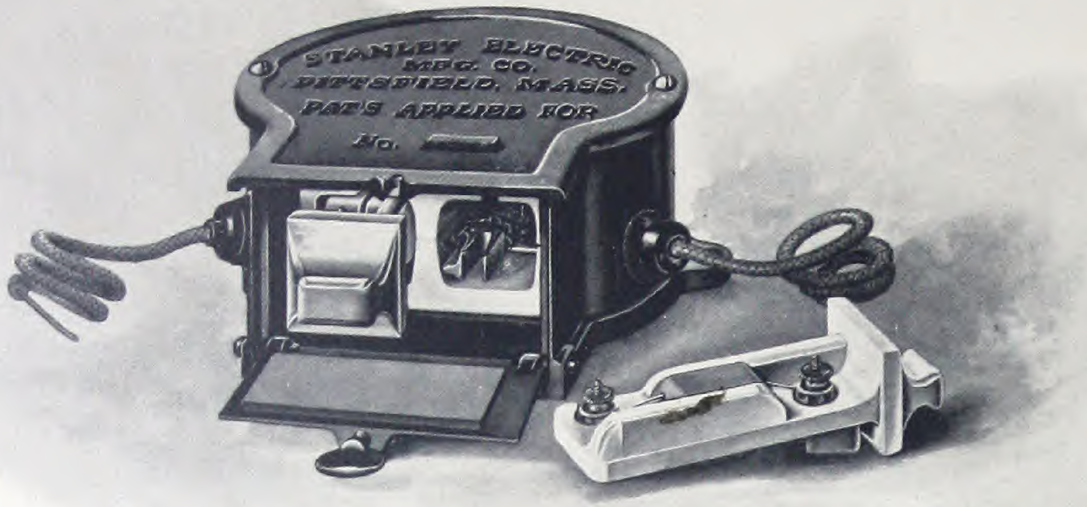
TYPE.	CAPACITY.	NO. OF LIGHTS.	NET WEIGHT.
No. 2.	500 Watts,	10 Lights,	56 lbs.
" 3.	750 "	15 "	68 "
" 4.	1,000 "	20 "	75 "
" 6.	1,500 "	30 "	99 "
" 8.	2,000 "	40 "	126 "
" 10.	2,500 "	50 "	139 "
" 15.	3,750 "	75 "	230 "
" 20.	5,000 "	100 "	292 "
" 30.	7,500 "	150 "	403 "
" 40.	10,000 "	200 "	490 "
" 60.	15,000 "	300 " { outdoor,	805 "
		{ indoor,	595 "
" 80.	20,000 "	400 "	800 "
" 100.	25,000 "	500 "	925 "

Types No. 2 and No. 3 are wound for only one secondary voltage; that is, they are either 1000 x 50, 1000 x 100, 2000 x 50 or 2000 x 100.

Types No. 4 to No. 20 inclusive have interchangeable secondaries; that is, they can be connected up for either 50 or 100 volts, as desired.

Types No. 30 to No. 100 inclusive have both interchangeable primaries and secondaries; that is, the same Transformer may be connected up for 1000 or 2000 volts on the primary and 50 or 100 volts on the secondary, as desired.

NOTE.—We mark the voltage on our Transformers in even 50s, instead of 1040 to 52 or 104 for instance, as some makers do. The ratio between primary and secondary, however, is the same in all standard makes; that is, either 40 to 1, 20 to 1, or 10 to 1.



Details of Transformer Fuse Box.

TRANSFORMERS FOR ARC LIGHTING.

Type.	Capacity.	Net Weight.
1A	Arc, for 1-10 Ampere Arc Lamp,	42 lbs.
1B	" " 1-14 " " "	56 "
2A	" " 2-10 " " "	56 "
3A	" " { 3-10 / 2-14 } " " "	73 "
5A	" " { 5-10 / 3-14 } " " "	93 "
7A	" " { 7-10 / 5-14 } " " "	128 "

These Arc Transformers are wound for the following voltages:—1000 to 30, 1000 to 33, 2000 to 30 and 2000 to 33.

Larger sizes will be made if desired.

TRANSFORMERS FOR TWO PHASE MOTORS.

Size.		Net Weight.
1 H. P.	In single case,	112 lbs.
2 H. P.	" "	131 "
3 H. P.	" "	217 "
5 H. P.	" "	243 "
7 H. P.	" "	521 "
10 H. P.	In two cases,	295 " each.
15 H. P.	" "	312 " "
20 H. P.	" "	484 " "
30 H. P.	" "	570 " "
40 H. P.	" "	760 " "
50 H. P.	" "	900 " "

These Motor Transformers are all wound for 500 volt secondaries.

SPECIAL TRANSFORMERS.

We make a specialty of building step up and step down Transformers and are prepared to submit estimates on any work of this class, manufacture promptly and guarantee results.

COMMERCIAL.

We are prepared to submit estimates on any class of alternating current work and carry out promptly and successfully anything we undertake.

Our manufacturing facilities are unexcelled for the class of work we propose to do, our new factory being equipped with traveling cranes, large tools and all modern appliances.

We solicit correspondence from all interested in

Central station companies furnishing light or power.

The long distance transmission of the energy of water powers for distribution of light or power throughout a town.

The conveyance to manufacturing establishments of the energy of water powers, not directly applicable, for lighting and power purposes.

We will gladly furnish estimates, plans and any information desired to those interested in any of the above projects.

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